THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 27. Thursday, June 7th, 1923. No. 355.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Pearlitic Cast Iron	453-456
Cupola Charging Devices	456
Moulding Sands	467
An Apprenticeship Course in Foundry Practice.—XLVI	460
Visit of H.R.H. The Prince of Wales to Messrs. Hadfields, Limited	462
Desulphurisation of Cast Iron	463
A Note on Foundry Costing	465
British Foundry Practice: Ferrous and Non-Ferrous	466
Trade Talk	468
Personal	468
Company News	468
Open Contracts	468
Gazette	468
Iron and Steel Markets	470

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

PRESIDENT, 1922-1923, Mr. H. L. Reason, M.I.Mech.E., Holloway Head, Birmingham.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.

Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.

Birmingham: H. Roe, 62, Stanhope Street.

Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.

Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.

London: V. C. Faulkner, 21, Stanley Gardens, W.11.

Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.

East Midlands: H. Bunting, 17, Marcus Street, Derby.

Coventry: J. M. Meston, 37, Melville Road.

West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Pearlitic Cast Iron.

Elsewhere in this issue is detailed the properties of what purports to be an innovation in the metallurgy of cast-iron. Whilst doubting this, we cannot help but congratulate Professor Bauer for giving the foundry world a designation to a composition of cast-iron which is self-descriptive. His work affords a useful base for the scientific classification of cast-iron which was either anticipated or confirmed by Mr. Colin Gresty in a Paper presented before the Newcastle Branch of the Institution of British Foundrymen and published on page 279 of THE FOUNDRY TRADE JOURNAL, in which he divided cast-iron into four categories based on the matrix as revealed by the microstructure. Professor Bauer's work suggests three categories—pearlitic, hypopearlitic, and hyperpearlitic cast-irons. For foundrymen, perhaps, the better wording would be pearlitic, supersaturated, and undersaturated. Thus it would be easy to prepare a classification to include all cast-irons and to discard the use of such terms as hard cylinder, common grey and the like, which lack definiteness. This would obviously make the combined carbon the basis for determining the category into which any iron-casting would be placed, and the base-word would be amplified to give other details; thus Professor Bauer's cast-iron "G" would be described as a 3 per cent. silicon high phosphorus undersaturated iron. The question obviously arises as to what advantage such a classification lends itself? Primarily, as it refers to matrix, the *result* of silicon is given, whereas a silicon basis only refers to something which causes results. Then, again, definite properties can be described, such as Professor Bauer's assertion that "a high sulphur content does not appear to be detrimental to pearlitic cast-iron." This statement is interesting in view of Mr. Young's assumption that sulphur is not detrimental *when adequately balanced by manganese*, and in his Table VII. of his Paper on the "Problem of Grey Iron Castings," read before the Institute of Marine Engineers, and reprinted in THE FOUNDRY TRADE JOURNAL on December 21, 1921, he clearly shows that higher transverse tests are invariably given when the manganese is relatively higher, the sulphur being high but constant. Unfortunately, in this particular table, only the total carbon is given, and this does not permit one to confirm Professor Bauer's statement. If, however, the higher manganese has operated in the direction of giving the pearlitic carbon content, it would lend more weight to the increased use of the classification of cast-iron, using the matrix structure as a base.

At the Manchester Conference it is to be hoped that one of the Papers to be presented will allow of the introduction of the subject of pearlitic cast-iron. Unfortunately, Professor Bauer gives little or no real information as to its production, and dismisses the question with a reference to a patent specification. However, we feel sure that British foundrymen will be able to devise a system for the control of the combined carbon so as regularly to produce irons of this composition, if they are of opinion that the results it shows warrant it. The actual heating up of moulds to a definite temperature, especially if at all high, does not appeal to us as being commercial. It is more on the lines of a suitable heat treatment of the casting itself which appears to be more commercial in its production aspect.

However, the commercial aspect apart, the results of the experiments are well worth repeating in this country, as in comparison with the other two irons, every test is higher. The Brinell hardness, too, is higher, but this does not necessarily imply that the machining costs will be higher. Broadly speaking, none of the earlier hardness tests represents the machinability of the sample used.

Foundrymen who contemplate experimenting, should bear in mind that it is with the dynamic tests rather than the static ones where the superiority of pearlitic cast iron is so clearly shown. We notice that Professor Bauer compares pearlitic cast iron with malleable iron and steel. This appears to us to be useless, because, as with all other cast irons, it shows practically no ductility, and therefore is not comparable. For Diesel and other cylinder work, especially if associated with controlled high-sulphur, pearlitic cast-iron would be successful. Contrary to what most foundrymen would imagine, the manufacture of controlled high sulphur iron is at a high level.

Pearlitic Cast-Iron: Its Production, Mechanical Properties and Possibilities.

In a recent number of "Stahl und Eisen," Professor Bauer discusses the possibilities of pearlitic cast iron.

The high carbon (pig-iron, cast iron) iron-carbon alloys solidify "white" unless a particular stimulus is present to cause the precipitation of graphite, and they accordingly consist of cementite and pearlite. Since white iron is so hard as to render it incapable of being machined, its use is greatly restricted in mechanical engineering work.

Cementite, however, is an unstable body which tends to dissociate into its two constituents iron (ferrite) and carbon (graphite or temper carbon).

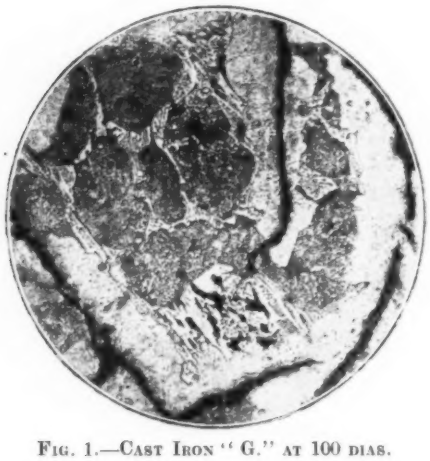


FIG. 1.—CAST IRON "G." AT 100 DIAS.

By suitable additions of silicon, which facilitate the deposition of graphite, and by slow transition through the cooling interval and generally slow cooling to below the pearlite point, it is possible in certain favourable conditions to push the dissociation to the point where the result is a cast iron consisting only of ferrite with deposited and foliated coarse graphite.

Ferrite is the softest constituent of the iron-carbon alloys, and the graphite does little to diminish the already low mechanical strength of the material. Apart from a few special cases, therefore, ferrite-graphite iron is but little used for mechanical engineering work.

Between both of these limiting conditions the hard and brittle "white" iron and the very soft ferrite-graphite iron, come the usual technical kinds of grey iron. Their micro-structure is dependent upon the chemical composition, the smelting and casting processes used, and the conditions of solidification and cooling after casting. The latter conditions are, of course, considerably affected by the cross-sectional area of the particular casting. In the microstructure of ordinary grey iron are generally found together varying quantities of graphite, ferrite, pearlite, and free cementite, and also phosphide eutectic, together with inclusions of iron or manganese sulphide.

A carbon steel containing 0.9 per cent. of carbon consists, when annealed, only of pearlite, the structure being uniform and dense. Owing to its excellent mechanical properties, pearlitic steel occupies a special position as compared with hyper-pearlitic and hypo-pearlitic steel. The idea occurred to the writer to produce a cast iron having a microstructure consisting mainly of pearlite with deposited graphite. A cast iron of this kind would naturally exhibit mechanical properties approximating those of pearlitic steel, and which would be influenced only by the graphite.

High Sulphur Content Possible.

Numerous tests carried out by different investigators in castings approximating in structure to pearlitic cast iron (pearlite-graphite) seem to lend confirmation to this fact. It was not found possible at first to get in current practice, and at any time, the pearlite-graphite structure desired. By systematic experiments A. Diefenthaler and K. Sipp were able to elaborate a process enabling the desired pearlite-graphite structure to be obtained with certainty.

The process in question has been patented since 1916, and in the meantime has been improved upon and has finally led to very definite rules for achieving the desired properties. It consists essentially in the combination of two media, in the variation of the furnace charge, and in the correct heat treatment of the moulds. The correct mixing is of course intended to give as little stimulus as possible to the formation of graphite. The materials used are carbon, silicon, and low-phosphorus pig-iron. It is also a remarkable fact that a high sulphur content, which most foundrymen fear more than anything, does not appear to be detrimental to pearlitic cast iron.

When cooled in the ordinary way, an iron of this kind would solidify "white." In order to preserve the desired pearlite-graphite structure, a slow rate of cooling is necessary, this being obtained by pre-heating the mould. The degree of pre-heating depends of course on the wall-thickness of each particular casting.

Theoretically speaking, it would be possible to get, from one and the same charge, and by suitable heat treatment of the mould, every desired cross-sectional area with the same final product (pearlite-graphite structure), when once the rates of cooling for the different cross-sectional areas had been determined. In practice, various cross-sectional areas are grouped together, and a special burden or charge selected for each group, assuming the same amount of pre-heating of the mould.

Properties of Pearlite Cast Iron.

The properties claimed for pearlite cast iron are said to be:—

(1) High transverse and tensile strengths and toughness.
(2) High resistance to impact stresses.
(3) Moderate hardness when properly treated.

FIG. 2.—CYLINDER IRON "Z." AT 500 DIAS.

(4) Only a slight tendency to the formation of "pipes," and hence the possibility of making complicated castings.
(5) Great resistance to sliding friction (abrasion).
(6) Fine and dense structure, the structure being unaffected by temperature changes.

Independently of the above workers, other investigators subsequently arrived at a similar estimate of the qualities of the pearlitic structure in cast iron, without, however, pretending to any knowledge of the satisfactory production of the material.

Tests Made.

The present writer has carried out some tests with a view to determining how far the high praise of this new type of cast iron is justified.

Three sorts of cast iron were used in the tests, viz.:—

(1) Ordinary cast iron such as is used for simple castings, such as are easy to work up into light castings without pretensions to particularly high strength (designated "G").

(2) The so-called "cylinder iron" for engine castings, etc., with a strength of from 11 to 15 tons per sq. in. (Z).

(3) Pearlitic cast iron (P).

Of each kind of material six standard test bars of 32 and 42 mm. diameter and 750 mm. length were cast. The moulds were jointless, dried, and blackened. Casting was carried out from the top. The moulds for the pearlitic cast iron were pretreated in accordance with the patented process.

The G and Z test pieces were cast from a cupola furnace working on a normal heat. The P test bars were cast from a crucible, the sulphur content being made intentionally higher than in the G and Z test bars (see Table I.).

The bars from each melt were numbered 1 to 12. The 42-mm. bars were numbered 1 to 6, and the 32-mm. diam. bars 7 to 12.

The cast bars numbered with the even numbers were submitted to transverse tests with the skin left on them, while the bars with the odd numbers were turned down from 42 and 38 mm. respectively to 32 and 28 m.

FIG. 3.—PEARLITE CAST IRON AT 500 DIAS.

These three micros have been reduced slightly on reproduction.

The following tests and examinations were carried out:—

(*a*) Chemical analysis.
(*b*) Examination of structure.
(*c*) Transverse tests.
(*d*) Tensile tests.
(*e*) Brinell tests.
(*f*) Alternating impact tests.
(*g*) Impact bending tests.

(*a*) *Chemical Analysis.*—The average analysis derived from an analysis on one bar each gave the figures shown in Table I. It is noticeable that the silicon content is low and the sulphur content of the pearlitic casting high. The combined carbon is lowest in G, slightly higher in Z, and approaches practically the eutectoid content in the pearlite casting P.

(*b*) *Examination of Structure.*—Fig. 1 shows the microstructure of test sample G5. It consists of graphite, ferrite, and pearlite, with considerable quantities of phosphide eutectic, as is usual in the structure of grey cast iron.

Fig. 2 shows the micro-structure of the "cylinder" iron "Z." At one spot the pearlitic matrix predominates, while phosphide eutectic, coarse graphite lamellæ, and but little ferrite are present. Larger quantities of ferrite were present at other places.

Fig. 3 shows the structure of P5. The matrix consists of pearlite with fine interdeposited graphite lamellæ. Phosphide eutectic is also present, but no ferrite.

TABLE 1.—*Analysis of Average Samples.*

	Total Carbon %	Graphite %	Combined Carbon %	Silicon %	Manganese %	Phosphorus %	Sulphur %
Cast Iron "G"	3.29	2.99	0.30	2.79	0.56	1.15	0.084
"Cylinder" Iron "Z"..	3.51	2.84	0.67	1.74	0.66	0.50	0.076
Pearlitic Iron "P"	3.25	2.41	0.84	1.11	0.79	0.40	0.154

In none of the three samples is the pearlite pronouncedly striated, but it should be noted that the cross-sections of the samples are small (42 and and 38 mm. diam.). With larger dimensions of

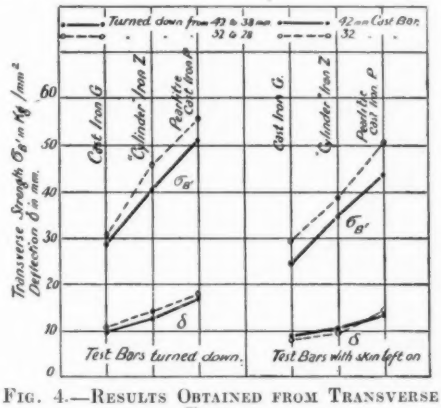


FIG. 4.—RESULTS OBTAINED FROM TRANSVERSE TESTS.

castings, in which cooling takes place more slowly, the pearlite generally assumes the striated form.

(*c*) *Transverse Tests.*—The results are shown in Fig. 4. They show:—

(1) That in all cases the test bars without the casting skin left on exhibit a higher transverse strength and greater deflection than the test bars with the skin on.

(2) The smaller diameter cast bars (32 mm.) exhibit in every case a higher transverse strength with the same deflection than the larger diameter cast bars (42 mm.).

(3) In every case the pearlitic cast iron exhibits the highest values for the transverse strength and for deflection, then follows the "cylinder" iron, and then ordinary cast iron.

The results of the tensile tests agree with those of the transverse tests.

(*d*) *Tensile Tests.*—The tensile test pieces taken from the 32-mm. cast bars exhibit greater strength than the test pieces taken from the 42-mm. bars.

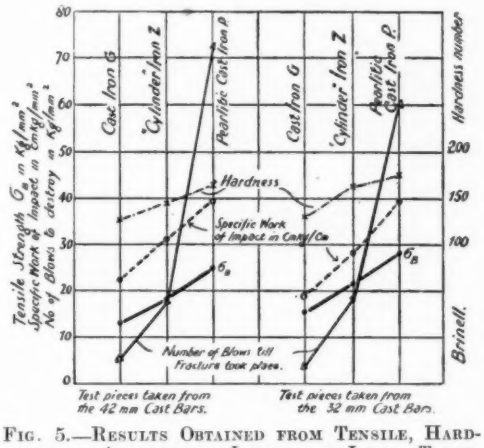

Cast Iron G
'Cylinder' Iron Z
Pearlitic Cast Iron P
Hardness
Specific Work of Impact in Cmkg/Cm²
σ_B
Number of Blows till fracture took place.
Tensile Strength σ_B in Kg/mm²
Specific Work of Impact in Cmkg/mm²
No. of Blows to destroy in Kg/mm²
Hardness number
Brinell.
Test pieces taken from the 42 mm Cast Bars.
Test pieces taken from the 32 mm Cast Bars.

FIG. 5.—RESULTS OBTAINED FROM TENSILE, HARDNESS, ALTERNATING IMPACT AND IMPACT TRANSVERSE TESTS.

The highest tensile strength is exhibited by the bars of pearlitic cast iron, and the lowest by the ordinary cast iron, the "cylinder" iron occupying the middle position.

(*e*) *Brinell Hardness.*—A 10-mm. diameter ball was pressed into the middle of the test piece under a load of 3,000 kilos. The period of load was one minute. The hardness values correspond

with the results of the transverse and tensile tests.

(*f*) *Alternating Impact Tests* (Fig. 5).—The tests were made with the Krupp alternating impact machine. The weight of the tup was 3,142 kg., and the drop 30 mm. The blows were applied to the specimens while the latter was being turned through 180 deg.

Speaking generally, the test pieces taken from the 42 mm. cast bars withstood a greater number of blows in the alternating impact tests than did the test pieces from the 32-mm. cast bars, but in some cases the differences are only slight.

In all cases the pearlitic iron bars showed by far the greatest resistance to impact stresses.

(*g*) *Impact Tests* (Fig. 5).—The test bars measured 10 × 10 × 100 mm. They were not notched. A small 150 cm.-kg. testing machine of the swinging type was used. In these tests also the superiority of the pearlitic cast iron is manifest.

Possible Uses of Pearlitic Cast Iron.

From the curves given, pearlitic cast iron has superior strength properties to the other kinds of cast iron tested. It would further appear that a casting made by the pearlitic cast-iron process must be practically free from stresses owing to its slower and more uniform cooling, whereas the ordinary types of cast iron show considerable strains due to casting. In every case where

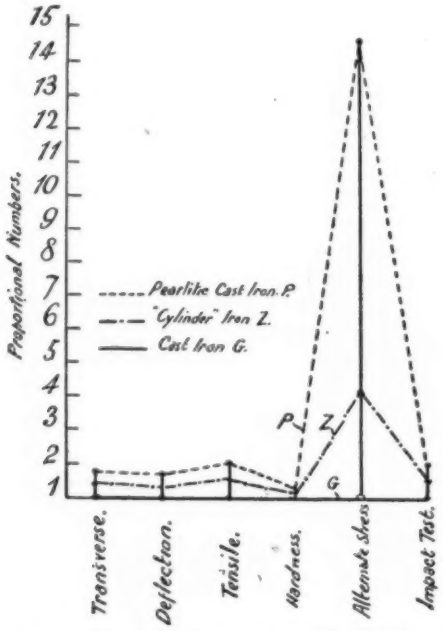


FIG. 6.—RELATIVE TESTS OF THE THREE IRONS, USING ORDINARY BASE LINE.

strength and safety are vital factors, pearlitic cast iron may be used with advantage. Amongst its uses may be mentioned:—

(1) *Parts of steam and internal combustion engines.*—Due to the excellent strength properties and the absence of strains in pearlitic cast iron, it can be cast lighter, thus saving both material and weight, especially in locomotives, marine engines, etc., where the question of weight is important.

(2) Its high resistance to abrasion (as found by other tests already carried out) indicates the use of the material where mechanical parts are subject to sliding friction (abrasion), *i.e.*, pistons, piston rings, cylinders, cross heads, gear wheels, etc.

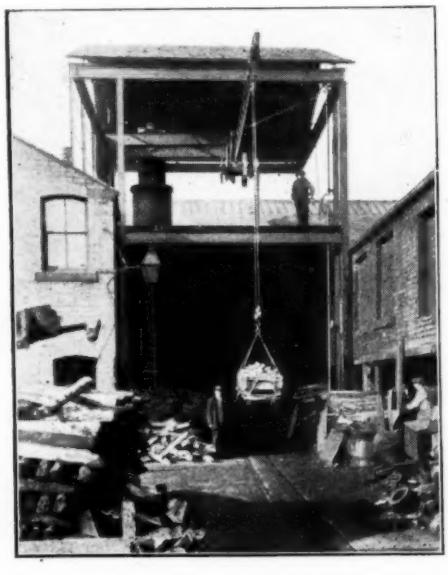
(3) Steel and malleable castings are often distorted and deformed owing to the heat treatment which they must necessarily undergo. Pearlitic cast iron maintains its original form, as it is not subsequently heat treated. Many parts which are now made from steel and malleable castings could with advantage be made from the new material in cases where the strength properties (e.g. expansion) of steel and malleable iron castings are not brought into play.

(4) It is a recognised fact that high-silicon cast iron tends to change in its structure when subjected to high working temperatures such as those which prevail in internal combustion engines. Up to about 1 per cent. silicon content the casting is stable in this respect, but beyond this content there is great tendency for the structure to be changed into the ferrite structure. Hence the advantage of pearlitic cast iron with its low silicon content for motor parts.

In conclusion, the writer is of opinion that the process for the sure production of the pearlite-graphite structure in cast iron (pearlitic cast iron) represents a great step forward in the foundry industry.

Cupola Charging Devices.

It is still an open question whether the mechanical charging of cupolas from the ground level is preferable to hand charging from a stage. If the latter is to be efficient, it is essential that the stage be roomy, protected from the weather, and that adequate means are provided for the elevating of the raw materials. Messrs. Wm. Wadsworth, of Bolton, have made a special study of this question and put forward two methods. The first is the normal electrically driven lift, but provided with modern fool-proof attachments. For instance, the electric switch is provided with



AN ELECTRICALLY-OPERATED MONO-RAIL DEVICE, WHICH REPLACES LIFTS FOR TRANSPORTING STOCK TO THE CUPOLA STAGE.

a detachable handle which precludes unauthorised persons from operating it. Chequer plates are used for the floor and so on. The second method is shown in Fig. 1, which indicates a system comparable with a lift with the exception that the furnaceman must climb up the stairs, and that time is wasted through slinging. However, as no foundations and little ironwork is necessary, it should constitute an apparatus capable of wide use amongst the smaller foundries at present carrying all materials to the stage by hand.

THE AUSTRALIAN CUSTOMS DEPARTMENT has decided that the operation of the deferred duties on the undermentioned tariff items has been postponed to the date indicated in each case:—Item 136 (F), iron and steel—hoop, September 30, 1923; Item 147, iron and steel, viz., plates and sheets, plain tinned, September 30, 1923; Item 152 (A), iron and steel tubes or pipes (except rivetted, cast, close jointed, or cycle tubes or pipes), not more than 3 in. internal diameter, iron and steel boiler tubes, September 30, 1923; Item 181 (B) (2), cables—telegraph and telephone, paper insulated, lead covered, July 1, 1923; Item 194 (D), chain n.e.i., not made up into serviceable articles, September 30, 1923

Moulding Sands.*

By O. Smalley, M.I.Brit.F.

Continued from page 438.

Interpretation of Tests.

To interpret these tests so that they may have practical application in the foundry and enable the development of suitable synthetic sands, some of the best-known and most widely used natural moulding sands will be considered. These have been tested in both the tempered and milled state. The details of preparation were as follows:—

Tempering.

A heap of the sand was wetted by a skilled sand-mixer, well turned over with a shovel and passed through a ¼-in. riddle. This was then allowed to stand overnight, well mixed with a shovel next morning, and passed through an ⅛-in. riddle for testing.

Milling.

Half of the heap of the tempered sand was charged in a mill possessing two rollers, one plain and the other toothed, weighing 16 and 15 cwts. respectively, and running at 16 revs. per min.

Green Sands.

It is customary in preparing facing sands to mix them with a shovel and pass through a disintegrator or a paddle mixer. If only one sand is used, it is usual to riddle through a ⅛ or ¼ in. sieve. For comparative purposes, tests have also been made on each sand after milling. Of course, it is not common to use a milled sand in this branch of moulding, but it is obvious that geological characteristics must be taken into consideration. Therefore, only by adequate milling can the best value be obtained from certain sands, and it is *quite essential* in the preparation of synthetic moulding sands. As far as possible, each sand was treated under identical conditions. The water content was determined by feel, the sand mixer judging by long past-experience.

As this Paper treats only the practical side of the question, the tests considered cover bond, permeability, mechanical-grading and moisture, as detailed in Table IV., selected as the fundamental essentials in the control of daily sand mixings, so far as the moulder is concerned. In order to judge the relative value of these figures, Table III. is given as a guide as to the desired properties for brass, bronze, Al., cast iron and steel, assuming, of course, that the worker is cognisant of the characteristics already detailed in Table II.

TABLE III.—*Specification for various Grades of Sands*

Metal.	Method of Moulding.	Permeability to gas in seconds Under.	Bond Dropping test. Over.	Moisture under.
			Inches.	Per cent.
Brass and bronze.	Hand	150	2½	7
	Machine.	150	3¼	7
Al.	Hand	200	2½	7
	Machine.	200	2½	7
Cast Iron.	Hand	60	2½	8
	Machine.	60	3¼	8
Steel.	Hand	50	2½	6
	Machine.	50	3¼	6

From these standards one has no difficulty in selecting a suitable sand for their specific requirements from those included in Table IV. They form a basis for the preparation of synthetic sands and for the control of the daily sand mixings. It is interesting to observe the effect of milling on the bond and venting qualities of the various types of

TABLE V.—*Detailing the effect of ramming on the venting qualities of Mansfield Sand and of Erith Loam for dry sand moulds.*

Sand.	Ramming.	Percentage of water.	Permeability figure in seconds.
Mansfield.	Light ..	6.7	41
	Normal ..		48
	Heavy ..		61
Erith Loam..	Light ..	11.2	Too friable to test.
	Normal ..		85
	Heavy ..		110

the natural bonded moulding sands most commonly used in this country.

Dry Sand.

The testing of a sand for dry-sand moulding is not subject to the personal element so much as the

TABLE IV.—*Showing the Development of Sands for Green Sand Moulding.*

Source.	Physical Condition.	Permeability to gas.	(Bond) Dropping Test in ins.	Moisture Content.	Mechanical Grading. Per cent. by Weight Retained on Sieves Mesh Power						
					20.	30.	60.	90.	120.	200	200 to the in.
Belgian Yellow	Tempered ..	47	3	7.8	10.0	2.0	14.0	47.5	3.0	8.0	15.5
Charleroi.	Milled 5 mins.	58	4⅜	7.6	—	—	—	—	—	—	—
Birmingham	Tempered ..	80	2½	7.9	0.13	0.08	5.62	63,58	3.25	16.48	10.86
Cemetery Sand.	Milled 5 mins.	110	2¼	—	0.04	0.06	5.45	65.48	1.03	16.96	10.98
	Milled30 mins.	—	3¾	—	0.01	0.08	5.03	56.18	4.70	16.88	17.12
Durham Ord. Loam.	Tempered ..	78	2⅝	9.7	—	0.01	0.30	17.85	1.20	26.9	53.74
Flasshouse.	Milled 5 mins.	132	2⅝	—	—	—	—	—	—	—	—
Erith Ord. Loam.	Tempered ..	75	2⅝	12.3	—	—	—	—	—	—	—
	Milled 5 mins.	107	3½	12.7	—	—	—	—	—	—	—
Glass Houghton	Tempered ..	70	2	9.75	1.0	—	5.0	85.65	—	5.3	2.65
	Milled 5 mins.	702	2½	—	—	—	—	—	—	—	—
	Milled 30 mins.	5,240	2¾	—	—	—	—	—	—	—	—
Hensall.	Tempered ..	33	1¾	6.7	0.01	0.06	12.0	58.0	4.0	15.0	11.0
	Milled 5 mins.	48	2⅜	—	—	—	—	—	—	—	—
Lenton.	Tempered ..	72	2¼	10.4	0.05	0.60	29.0	41.0	4.0	14.0	11.0
	Milled 5 mins.	300	3	—	—	—	—	—	—	—	—
Northallerton Red	Tempered ..	Unsuitable condition. Milling essential before use.									
Rock.	Milled 5 mins.	62	3½	6.3	—	—	—	—	—	—	—
Sand Glass and	Tempered ..	41	2¼	7.0	—	2.5	2.5	76.0	3.0	11.0	6.0
Foundry Loam. No. 1 Yellow. South Cave.	Milled 5 min.	43	2⅞	—	—	—	—	—	—	—	—
Sand Glass and	Tempered ..	64	2¼	7.5	—	—	1.56	13.56	2.82	58.03	24.03
Foundry Loam. No. 3.	Milled 5 mins.	79	2⅜	—	—	—	—	—	—	—	—
Worksop Red.	Tempered ..	60	2¼	8.4	—	0.10	1.5	47.0	1.0	29.0	22.0
	Milled 5 mins.	63	3½	—	—	—	—	—	—	—	—

* A Paper read before the London Branch of the Institution of British Foundrymen, Mr. Wesley Lambert presiding.

testing of green sand. To demonstrate the effect of ramming and varying quantities of water on the *strength* and *venting properties* after baking, Mansfield red sand and Erith loam will be considered. The test-pieces were prepared under similar conditions, with the exception of the variable in question.

Conclusions.—The permeability of a dry-sand mould is not materially affected by excessive ramming, the drying of a hard-rammed sand being sufficient guarantee of the passage of gas through the mould, providing that due care has been exercised in the choice of the sand in the first place.

TABLE VI.—*The effect of Varying Percentages of Water on the Permeability of Mansfield Sand and Erith Loam when made into dry sand moulds.*

Sand.	Percentage of water.	Permeability figure in seconds.
Mansfield	3	48
	6	48
	13	110
Erith Loam	6	47
	12	80
	15	82
	25	216

Each was rammed and dried under identical conditions.

Conclusions.—It is essential that the wetness of moulding sand be kept under rigid control. If possible, this should be estimated daily, although it may be tested by picking up a handful. If the sand retains its form and leaves the hand clean, it is satisfactory, but if the grains stick to the hand it is too wet. Should the sand leave the hand clean, yet crumble on the release of the pressure, then it requires further dampening.

Full details regarding the relative properties of various sands for dry sand moulds are embodied in Table VII.

Belgian Yellow.

A coarse-grained high silica sand of good refractory powers, possessing a good bond and is self-venting. It is highly suitable for both moulds and cores for iron and steel where cost permits. It will also be observed that in the new state there is nothing to be gained by milling.

Birmingham Cemetery Sand.

In the tempered state it is open, permeable, but weak and somewhat friable. When lightly milled it is strengthened without seriously affecting the permeability. Overmilling should be studiously avoided, the nature of the sand being such as to readily disintegrate, and although accompanied by an increase in strength, there is a marked fall in the permeability. It is good sand for Al., brass and iron, but its physical treatment must be under strict observation.

Durham Ordinary Loam.

An exceedingly fine-grained sand, rich in a weak bonded clay, and of little value for dry sand work. Observe the remarkably poor venting qualities after light milling, a period of 7 hours being occupied in the passing of 600 c.c. of air through the standard permeability test-piece.

Durham Loam (Strong Grade).

This is really a common clay, and of little value in the foundry.

Erith Loam (Ordinary Grade).

A comparison of the tests obtained from this material with those obtained from the ordinary grade of Durham loam characterises its remarkable superiority, although possessing a similar texture. Erith loam is a close-grained refractory sand, having good strength and reasonable permeability. It is a material which has its use in every foundry, and is perhaps the most general blending sand we possess, and widely used in reclaiming old sand.

Glass Houghton.

A yellow sand, uniform in grade, highly refractory, possessing good bond and permeability. Highly suitable for iron, steel and brass castings of all forms and dimensions, both for moulds and cores. It possesses good life, and has its own peculiar value as a blending sand.

Hensall.

An open red sand, of special value in the iron and in the steel foundry, for the manufacture of moulds and cores. Whilst not so refractory, it is equivalent in every respect to Glass Houghton or

TABLE VII.—*Detailing the Testing of Sands for Dry Sand Moulding.*

Source.	Physical Condition.	Temperature and time of baking.	Permeability to gas in secs.	Transverse tests (ozs.)	Moisture content of sand before use.	Mechanical Grading. Per cent. by Weight Retained on Sieve Mesh. 20.	30.	60.	90.	120.	200.	200 to the in.
Belgian Yellow	Tempered ..	400° F. for 4 hrs.	55	132	10.2	10.0	2.0	14.0	47.5	3.0	8.0	15.5
	Milled 5 mins.	,,	72	136	9.6	—	—	—	—	—	—	—
Birmingham Cemetery.	Tempered ..	,,	45	53	7.9	0.13	0.08	5.62	63.58	3.25	16.48	10.86
	Milled 5 mins.	,,	76	199	8.4	0.04	0.06	5.45	65.48	1.03	16.96	10.98
	Milled 30 mins.	,,	440	608	8.9	0.01	0.08	5.03	56.18	4.70	16.88	17.12
Durham Ord. Loam.	Tempered ..	,,	3,270	79	16.5	—	0.01	0.30	17.85	1.20	26.9	53.74
	Milled 5 mins.	,,	25,000	316	—	—	—	—	—	—	—	—
Flasshouse	Milled 30 mins.	,,	25,000	384	—	—	—	—	—	—	—	—
Durham Strong Loam.	Tempered ..	,,	2,820	120	16.9	—	—	—	—	—	—	—
	Milled 5 mins.	,,	29,000	329	—	—	—	—	—	—	—	—
Flasshouse	Milled 30 mins.	,,	30,000	480	—	—	—	—	—	—	—	—
Erith Ord. Loam.	Tempered ..	,,	57	42	11.2	—	—	—	—	—	—	—
	Milled 5 mins.	,,	87	125	—	—	—	—	—	—	—	—
	Milled 30 mins.	,,	—	259	—	—	—	—	—	—	—	—
Glass Houghton	Tempered ..	,,	85	78	9.75	1.0	—	5.0	85.65	—	5.3	2.65
	Milled 5 mins.	,,	95	220	10.70	—	—	—	—	—	—	—
	Milled 30 mins.	,,	380	352	11.20	—	—	—	—	—	—	—
Hensall	Tempered	,,	35	100	9.8	0.01	0.06	12.0	58.0	4.0	15.0	11.0
	Milled 5 mins.	,,	40	320	10.2	—	—	—	—	—	—	—
Lenton.	Tempered ..	,,	46	160	10.5	0.05	0.60	29.0	41.0	4.0	14.0	11.0
	Milled 5 mins.	,,	60	270	10.9	—	—	—	—	—	—	—
Mansfield.	Tempered ..	,,	130	90	9.2	—	—	—	—	—	—	—
	Milled 5 mins.	,,	—	—	—	—	—	—	—	—	—	—
Northallerton. Red.	Tempered ..	,,	52	80	8.0	2.0	0.5	6.0	47.0	4.6	21.0	18.0
	Milled 5 mins.	,,	—	710	—	—	—	—	—	—	—	—
	Milled 30 mins.	,,	—	1,010	—	—	—	—	—	—	—	—
Sand Glass and Foundry Loam No. 1 Yellow.	Tempered ..	,,	32	18	—	—	2.5	2.5	76.0	3.0	11.0	6.0
	Milled 5 mins.	,,	45	39	—	—	—	—	—	—	—	—
Sand Glass and Foundry No. 3.	Tempered ..	,,	52	38	7.5	—	—	1.56	13.56	2.82	58.03	24.03
	Milled 5 mins.	,,	174	50	8.9	—	—	—	—	—	—	—
Steel Makers Composition.	—	—	300	89	—	41.0	11.55	12.58	15.39	1.44	4.27	13.79
Worksop. Red.	Tempered ..	,,	58	76	8.5	—	0.10	1.5	47.0	1.0	29.0	22.0
	Milled 5 mins.	,,	3,600	442	9.6	—	—	—	—	—	—	—

Belgian Yellow. It is used principally as a blending sand in the manufacture of large oil sand cores, 20 per cent.—30 per cent. being recommended in conjunction with sea-sand, to enable the core to stand up to the hot metal better.

Lenton.

A good sand recommended for both moulds and cores for iron and steel. In many respects it is the equivalent of Hensall, possessing rather finer moulding properties, a characteristic somewhat difficult to express quantitatively, but one that is well known to all moulders.

Mansfield.

For general utility Erith is possibly the only equivalent of this sand, which finds equal favour in the ferrous and non-ferrous foundry for the construction of both moulds and cores. It possesses good life, and is of special value as a blendener.

Sand Glass and Foundry, No. 1, Yellow.

A sand of possible value for steel, brass and Al., but is on the weak side for iron castings of any dimension.

Sand Glass and Foundry Loam, No. 3.

A useful material, but on the weak side.

Worksop Red.

This is a sand of which the author has had little experience, but from an examination of tests it should prove of value in the manufacture of small iron and steel castings, and also for all forms of brass, bronze and Al. work. It must, however, be used with considerable discretion, because of the ready degradation of the grain size in milling and in use.

Steel Makers' Composition.

The tests for this material, which were supplied by one of the best known Sheffield manufacturers, are included for purposes of comparison, and may be interesting to those familiar with this material.

Loam.

The physical requirements of loam are determined by the conditions under which it is to be used, the materials available locally and cost. The essential properties of loam are:—(*a*) Low shrinkage on drying; (*b*) strength; (*c*) porosity; (*d*) permeability; (*e*) refractoriness; (*f*) rubbing.

The loam mixtures used in the foundry to-day are legion, every foundryman possessing mixtures of his own, which have served his purpose at some time or another. It is no uncommon thing in busy times for a loam mixture to be changed weekly according to the whims of the moulder or the happenings of the foundry.

In the author's personal experience the commonest troubles with loam moulds and cores are:—(1) Flaking of the face; (2) scabbing or buckling; (3) blowing; (4) contraction cracks; (5) too strong.

Loams may be placed in three general categories:—(1) Building loams; (2) mould loams; (3) core loams.

Each is a claying sand, usually milled with floor sand to a slurry of 20 to 25 per cent. H_2O, opened by means of sea-sand, ashes, cowhair, horse dung, sawdust, etc. One could almost fill a volume with the numerous mixtures in each class that have proved successful in one foundry and failed in another, and yet convey little or no information of the actual requirements of a loam. As it is impossible to give in one lecture the synthetic development of loams, which has occupied a close study over a period of years, and render possible a full interpretation of the requisite physical properties, so that one may intelligently compare one loam with another, the effect of three of the principal factors which enter into the preparation of loams, viz., milling, water content and rate of baking, will be briefly dealt with.

Erith loam is chosen for these experiments on account of its universal adoption and familiarity to all connected with loam moulding. From the results given in Table VIII. the moulder will have no difficulty in appreciating some of the changes which are exposed in the preparation of many of the complex loam mixtures, and in realising the fundamental importance of precise control throughout.

TABLE VIII.—*Showing the Effect of Milling Erith Loam.*

Time.	Water content.	Transverse strength baked 4 hrs. at 400°F.	Permeability to gas in seconds.	Volume changes after baking at 400°F. for 4 hrs.
As received ..	10.1	42	87	Nil.
Tempered overnight	21.9	276	730	4.47
Hand milled ..	23	492	927	6.62
Milled 5 mins. ..	22.8	547	1,700	7.67
Milled 15 mins...	21.9	579	1,945	8.26
Milled 30 mins...	22.7	604	2,528	8.43

These experiments show that *little mechanical action* is necessary to obtain the best combination of properties from loam, and that *hand milling* almost doubles the strength. With mechanical milling, the most satisfactory available combination of desirable properties is obtained after 5 minutes' milling. Further milling only grinds the loam into a finer state of division, thus reducing the permeability to gas and increasing the contraction on drying without materially improving the strength.

TABLE IX.—*Showing the Effect of Varying Percentages of H_2O on the Physical Characteristics of Erith Loam.*

Treatment.	Percentage of Water.	Transverse.	Permeability.	Volume Change.
Milled 5 mins. ..	11.4	148	72	1.3
Water added and milled 2 mins. ..	19.8	530	690	6.62
Water added and milled 2 mins. ..	21.5	650	2,200	8.31
Water added and milled 2 mins. ..	28.97	448	1,095	8.67

These experiments demonstrate broadly the progressive effect of increasing quantities of water, and emphasise the importance of control. The low permeability of the sample containing 28.97 per cent. H_2O is explained by the cracking following the removal of the H_2O, and is not due to any change in the loam itself. It exemplifies the importance of selecting suitable loams for rotating cylinder cores, where 25 to 29 per cent. water is necessary. With a rotating strickling board less water may be used, and 20 to 22 per cent. is best practice.

Effect of Rate of Baking of Correctly Milled Erith Loam.

That the elimination of 25 per cent. H_2O from a loam should be conducted with considerable care and without undue haste is palpable even to the unsophisticated. It is an every-day practice, however, to find the moulder disregarding these precautions, and will sweep a jou and have it in a stove within a few hours, yet is surprised to find it badly cracked or flaked or lifted bodily from his bricks or plate. At times the lift may be scarcely discernible to the eye, and the result is a buckled casting. *Control of drying* is possibly the most important feature of loam moulding. There *is more chance of success from a poor loam* which may be *dense, impermeable to gas and of high contraction if carefully dried, than there is from an ideal loam carelessly dried.* Drying should be gradual, commencing from an air drying and finishing at 400 to 500 deg. F. for ordinary brass, bronze and iron castings, and at 600 deg. F. for iron castings of any dimension which must be poured hot.

In closing this Paper, it should be emphasised that all that has been attempted is to give a general survey of an almost unexplored field, and whilst the Paper only briefly considers the properties of various sands, it particularly defines the practicability of control of these same properties desirable in good moulding sands. From the limited test results given, the foundryman may be able to formulate a helpful and commercial standardisation of moulding sands in accordance with his every-day *needs*.

The author wishes to place on record his indebtedness to the directors of Messrs. Sir Armstrong Whitworth & Company, Limited, for permission to publish the results.

XUM

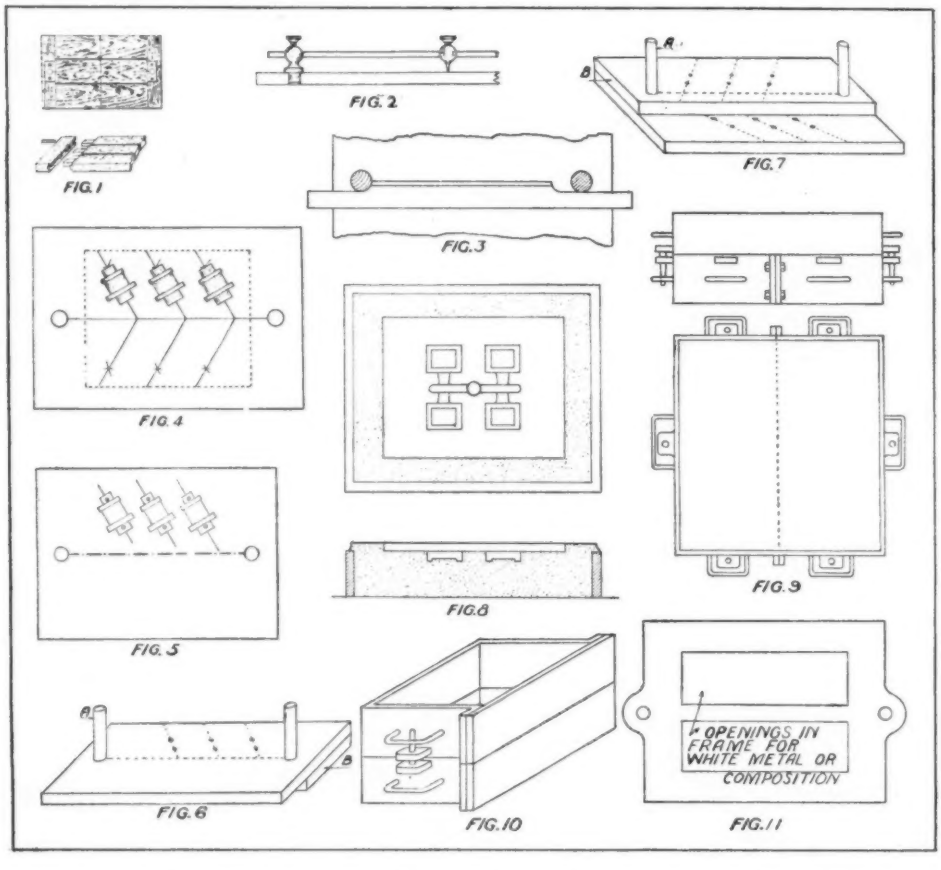
An Apprenticeship Course in Foundry Practice.—XLVI.

By Ben Shaw and James Edgar.

PATTERN PLATES AND PLATE MOULDING.

In considering the production of castings, the size and character and also the quantity required have an important bearing on the procedure adopted, there being considerable difference in the preliminary operations, according to whether they are of standardised type or whether only a few are required to any one design. When the special shape is defined, and hundreds of castings are required, it is important for economical reasons to explore every avenue with a view to limiting the cost of their production. The speed of production is governed largely by the facilities in the foundry doing the work, but whether a foundry is well equipped for dealing with repetition work or not, the actual labour involved per casting can invariably be considerably reduced by adopting some form of pattern plate for making the moulds. If large work be excluded, there are few forms of castings the moulds for which cannot be made more rapidly by means of a pattern plate. Even for large work, providing the number of castings required warrant the preparatory outlay, the use of a plate could frequently be advantageously employed for increasing the rate of production. In small work the use of a pattern plate is essential to cope with the need for rapid production and the reduction of costs. It is an acquisition when the moulds are prepared by hand, but foundries that make a speciality of repetition work invariably use machines because the rate of production is considerably increased.

In principle the plate upon which patterns are fixed, or to which they are cast, is similar to the ordinary ramming board or oddside which might be used when only a few castings are required, but the idea is extended so that each part of a mould is prepared on the special ramming board or pattern plate. With the ordinary ramming board, the pattern, patterns, or pattern sections are loosely located in position, and each must be stripped separately, instead of being secured on a pattern plate and all stripped at one time. Then, while the joint and runners need to be formed for each mould prepared on a ramming board, pattern plates are so prepared that moulds made on them are ready for assembling at once. The special advantage of pattern plates, therefore, is the cutting out of tool operations that would otherwise be involved in the preparation of each mould. With a proper pattern plate, no tooling whatever should be necessary. For this requirement it is essential that every care be taken in the preparation of a suitable plate in order that moulds made from it will be accurate.



The Plates.

The plates upon which the patterns are fixed may be of wood or metal, or, instead of locating the separate patterns, a cast plate may be prepared with the patterns cast in position.

Many foundries use wood plates for small work. They are made to standard dimensions, according to the sizes of the boxes to be used, and have wrought-iron dowel plates set in to suit the box pins. An illustration of a suitable wood plate is shown in Fig. 1. It will be noted that the cross-pieces are secured by means of mortise and tenon joints wedged together to reduce the possibility of twisting. The plate can, with advantage, be formed with slightly open joints, as shown, in order to minimise any change of form, but, in any case, they should be painted or varnished to exclude moisture. Wood plates, besides being

suitable for flat joints, can be cut or have pieces attached to modify the joint to the requirements of the work. Generally, for flat jointed work, standard cast-iron plates are made, and machined all over, to which patterns can be attached. Both these types of plates need to be very carefully lined off, so that the patterns may be set accurately upon them to ensure a correct junction, when the drag and cope are placed together for casting. The patterns to be fixed to these plates may be of wood or metal. Wood patterns mounted on a plate withstand wear remarkably well when hand ramming is resorted to, and their service is increased when power ramming is applied, but when a number of similar patterns are mounted on a plate, it is frequently more economical to prepare a number of metal patterns or pattern sections. For this purpose a master pattern is required having double contraction allowance and some allowance for finishing, according to the design of the work. For small work a double contraction allowance is not necessary, as the rapping will make up for any deficiency due to contraction, or, even with larger work, the special master pattern may not be essential if non-shrinking pattern metal is used.

Metal Patterns.

In making metal patterns there are a number of mixtures that can be used with advantage. When the work is small, iron patterns are not suitable, because they require considerable care to prevent corrosion when in storage. As a rule, white metal or brass is used for such work, though aluminium offers many advantages, because of lightness coupled with durability. In brass foundries the tin-zinc alloys are frequently used for patterns, because they can easily be incorporated in standard mixtures when they have ceased to be useful as patterns. The use of antimony in pattern mixtures, while useful as a hardener, is not generally adopted in brass foundries, because it is so rarely introduced into standard mixtures, unless a speciality is made of this class of work and a special pattern mixture is prepared for dealing with patterns only; then the non-shrinking mixture, consisting of 85 lead, 10 antimony, and 5 per cent. tin, is more generally used. This is a suitable mixture when only one pattern is supplied from which hundreds of castings are required, but, if antimony is objected to, because of possible contamination with other mixtures, an alloy of equal parts of tin and zinc is useful in the case of small work, since the shrinkage is only about 1-64 in. to the foot; hence the patterns could be used as a master pattern without any appreciable difference. Considerable care must, of course, be taken in the preparation of the mould for these patterns so that what finishing may be necessary will not affect the size of the castings desired. Not infrequently metal patterns are made from the mixture most commonly used in the foundry, and much labour is involved in finishing and fitting them to a plate so that they will make a perfect strip.

Mounting Patterns on Plates.

When the work to be done is symmetrical and each box part carries half the mould, or when the whole of the mould can be prepared in the drag necessitating a flat cover, only one side of the plate need be used. In the former case, the accurate setting of the half patterns is essential, because both cope and drag impressions are made from the same side, and they must coincide and form the complete mould when brought together. To do this successfully, all plates should have centre lines scribed on them. For this purpose special trammels should be used, having a pivotal leg formed so that it fits neatly in the pin-hole of the plate, as in Fig. 2; the other head on the trammels may have an adjustable scriber. This tool is not only suitable for making centre lines at right-angles to a line passing through the centres of the pin-holes, but, with different fitments to the head, it may also be used advantageously for checking the pattern sections, when they have been located. A small steel straight-edge made to fit against pins, as in Fig. 3, is useful for the horizontal centre line. This straight-edge also provides a bearance for a set-square when the patterns are to be set at an angle to the horizontal centre. A method for marking off the positions of half patterns is illustrated in Fig. 4. Although many depend entirely upon marking off for the correct location of the half patterns, however skilfully it is done, inaccuracies occur, and it is not always easy to rectify slight errors once the patterns have been secured. Another method which has the advantage of being equally suitable for locating either wood or metal patterns on a wood or metal plate is illustrated in Figs. 5, 6 and 7. For this method two holes are required to be bored or drilled through each complete pattern. It is not necessary that the pitch of the holes should be exactly similar in each pattern, but corresponding half-patterns should be marked so that they will occupy relative positions on the plate. The procedure is to locate one-half of each pattern on the plate, as in Fig. 5, securing them so that holes can be drilled through the jig B, so that pins corresponding to the box pins can be inserted. The smaller holes through the plate can then be produced through the jig, and, by reversing the jig, as in Fig. 7, corresponding holes can be drilled through the other side of the plate. The guide pins AA should be inserted after the jig is reversed, and the jig must be turned upside down, and not end for end. When the holes have been drilled in this way, pins need to be passed through the half-patterns and allowed to project so that they will register on the plate, and it is important to be quite sure that the corresponding half-patterns are opposite to each other. When the design of the required castings is such that both sides of the plate are necessary, it is generally referred to as a double-sided pattern plate. In this case the pattern sections need to be directly opposite to each other, so that, if projected through the plate, they would accurately coincide. Locating the parts by marking only is, if anything, more difficult than in the previous case, and, since accuracy is the key to successful plate work, marking the positions should not be depended upon if more dependable methods can be adopted. By drilling holes through the patterns in a similar manner to that described for the single-sided plate, the pattern sections can be located and fixed on one side, to enable the plate to be drilled, the holes corresponding with those through the patterns. The use of neatly-fitting pins will ensure accuracy in locating the corresponding halves of the patterns on the other side of the plate.

Cast Pattern Plates.

Many pattern plates are cast with the patterns as one piece, either in the form of a double-sided or match plate, when each side is used for the cope and drag respectively, or as a reversible plate, when the patterns are carried on one side only, from which both impressions are made. The impressions in this latter form are reversed when assembled for casting.

Considerable skill is required in making the moulds for cast plates of either type, but more particularly with regard to the reversible plate It must be remembered that all the subsequent castings made depend upon the accuracy and finish of the pattern plate, and much patience and skill is required to obtain a perfect result. The production of these plates is usually specialised, one or two moulders of proved ability being responsible for the work. The double-sided plate does not necessarily need special boxes or jigs. In making this form of plate a suitable box larger than the outside dimensions of the required plate is procured and the mould prepared from the patterns in the usual way, greater care, however, being taken to give a very fine surface. Special attention must be given to venting. The runners are cut in the manner experience proves to be best for the work in hand. A gate and riser should be prepared for casting the plate. When the pattern moulds are ready a pattern of the plate is located on the drag and inside the box part. The shape of this plate will depend upon the manner in which subsequent moulds are to be made, whether by hand or machine. For the former convenient handles are frequently cast on, while a plain rectangular plate is more common for machine use. The thickness of the plate varies, according to its size, from $\frac{1}{4}$ to $\frac{1}{2}$ in. When sand has been made up to the thickness of this plate, as in Fig. 8, and runners made, the plate is removed and the mould closed. It must

be very carefully clamped before being cast. This type of cast plate may be made of cast iron, brass or aluminium, and pin holes are usually drilled to suit the boxes that are to be used. Many white metal or composition plates are made, however, and for these specially prepared frames are used which become part of the plate. These frames are prepared to spit special boxes, and the inside edges are grooved or carry projections for giving support to and binding the metal or composition to them. When these are used, a box may be used of similar size to those that are to be used later, the frame is then located on the pins and clamped between the box parts during the time of casting. In some cases plaster-of-Paris moulds are prepared, in which plates of this type are cast. They provide a very smooth finish, and very little, if any, finishing of the cast plate is necessary.

Reversible Match Plates.

The reversible match-plate is a more difficult proposition, and necessitates some form of jig. There are quite a number of ways by which these plates can be made, but it will suffice if we show one method for the solid cast plate and another cast in a frame. As the shapes for both drag and cope are required on one side, it is necessary to prepare the moulds from the master patterns in such a way that they can be placed together to form the drag of the plate mould, or partitioned so that each can be cast separately. The former method is suitable for a solid cast plate, and special boxes are necessary. A suitable box is illustrated in Fig. 9, the drag of which is prepared in two equal parts and flanged at the joint for bolting or clamping together. The joint requires to be machined. It will be noticed that besides the pins and pin holes for registering the box parts as shown the drag carries separate pin holes for introducing loose pins. With this form of box the drag is, in the first place, separated, and a blank side secured to each part. These then form the two parts for a separate box, as shown in Fig. 10, in which the mould can be made. Room is required about three sides to properly enclose the size of plate with which the patterns are required to be cast. When the mould has been completed the blank ends are removed and the two parts again secured to form the drag for the plate mould, then the thickness of plate is made up in the same way as in the previous instance. A flat cope is prepared on a ramming board to cover the drag. When soft metal or composition is to be cast in a frame the impressions of the drag and cope are cast separately. For this purpose the frame requires a division between the two parts, as shown in Fig. 11. A corresponding partition may be used in the box parts, or narrow boxes may be used in which the mould is prepared from the master patterns. When completed the parts are separated, the frame located, and a flat cover used to enable the drag part to be cast. The frame is then located on the cope and a flat cover again used.

These reversible pattern plates are preferred for small work made on a machine, whether hand or mechanically rammed, because each pair of box parts that are prepared can be closed and made ready for casting at once, whereas, with the double-sided plate, a number of drags are made before the plate is turned for making the copes. The number of master patterns used provide double the number of moulds with the reversible plate, it has therefore a certain economy in pattern-making, but cores cannot be so conveniently employed as with the double-sided match plate.

The making of reliable pattern plates of whatever type is an expensive undertaking, and it is necessary to be quite sure that the quantity of castings required will compensate for the outlay. On the other hand, when very large numbers of castings are required, with possibilities of repeat orders, no expense, within reason, should be spared to make the pattern plate as near perfect as possible. Trial moulds should be made and cast so that desirable modifications may be made, if necessary, before the plate is actually used for production.

Moulding Boxes.

It is important that the boxes used in connection with plate moulding should be of standard type. They should be interchangeable with accurate fitting parts. Many moulds from pattern plates are prepared in snap flasks, from which they are removed after the moulds have been located for casting. The use of these reduce the need for a large quantity of boxes, but their use is limited to work which offers little pressure, although the size of work done in this way can be increased if castings are available for giving support to the moulds when the snap flask is removed. Opinions differ respecting the most convenient and accurate method of registering the box parts. It is generally recognised that two pins are best for small work, and, although the shape of pins in use vary much, we prefer the round pin possessing taper and the minimum clearance to ensure an accurate assembly. To prevent faulty closing, each part should carry a pin.

Apprentices should familiarise themselves with the various types of pattern plates and the manner in which they are made, because the necessity for their use is increasing, and will continue to increase.

Visit of H.R.H. The Prince of Wales to Messrs. Hadfields, Limited.

On Tuesday last H.R.H. the Prince of Wales, K.G., K.T., visited the East Hecla Works of Messrs. Hadfields, Limited, at Sheffield, to view the starting of the new 28-in. rolling mill. Owing to the unfortunate condition of the iron and steel trade, this mill, which has been practically completed for some time, had not been placed in commission. Its starting up may be an indication that the steel trade is improving, and that, in Sheffield, the long period of depression is passing.

PORTRAIT OF H.R.H. THE PRINCE OF WALES, K.G., K.T., CAST IN MANGANESE STEEL AT THE WORKS OF MESSRS. HADFIELDS, LIMITED, SHEFFIELD.

A feature of the Prince's visit was the casting of his portrait in steel in his presence. Our illustration shows the plaster cast of the plaque, which is about 20-in.diameter.

Another important event which took place last Saturday was the opening of the sports ground of Messrs. Hadfields. The total area of the new ground is about 14 acres, and is about 15 minutes' walk from the East Hecla Works. The sports ground includes cricket grounds for the seniors and juniors, covering together about 3 acres; also football grounds covering a similar area. Then there is a hockey ground of 1¼ acres, two bowling greens, six tennis courts—three laid with grass and three with gravel—and a running track about ¼-mile round, which includes a sprinting track of 100 yards dead level. The present membership on a voluntary basis is already about 1,200.

French Currency in the Saar District.—As from July 1 next French francs are to form the legal currency in the Saar district.

Desulphurisation of Cast Iron.*

By Dr. Richard Moldenke, Watchung, N.J.

One of the most serious problems confronting the foundry is that of a constantly increasing sulphur content in its scrap supply. With every remelting of iron in cupola or air furnace, sulphur is absorbed from the fuel, and the resulting molten metal runs from one to five hundredths of a per cent. higher in this undesirable element. The greater part of the foundry product, sooner or later, finds its way into the country's scrap piles, and with ever greater percentages of this scrap going into the daily foundry mixtures, the sulphur problem is gradually becoming acute.

At the time of his entry into the foundry industry, in 1890, the writer remembers that his first analyses of various pieces of characteristic scrap showed a composition of about 0.05 sulphur. Comparison of data with friends who had been making the laboratory an important and indispensable adjunct to steel-making at the time confirmed this situation. As the years went on, the constant remelting of our scrap supplies ran the sulphur average higher, so that by 1900 the sulphur had nearly doubled. At any rate, the first specifications for cast-iron products recognised 0.10 sulphur as allowable for heavy castings. And still this sulphur increase went on, so that by war-time 0.14 was a common situation. The upsetting of all standards of practice during the war, when, through absence of pig-iron, periodically scrap proportions soared up to 90 per cent. in a mixture, and oftentimes no pig was used at all, has meant a probable present average of 0.18 sulphur in the scrap, with the worst yet to come when the war castings finally arrive in full force. Thus will the scramble for money regardless of consequences be followed by the usual costly reckoning such a method deliberately invites.

In ordinary normal foundry procedure an undue sulphur content in the daily work is prevented by the use of as large a pig-iron percentage in the mixture as may be economically possible. From the nature of the blast-furnace process, it is possible to get pig-irons with reasonably low sulphur percentages, so that the problem becomes one of diluting the sulphur in the scrap and that added during the melting. Unfortunately, this ordinary normal procedure is not possible at the present time, for pig and scrap percentages are such that an increase in sulphur results in spite of the dilution in question, and castings with sulphur up to 0.25 are of common occurrence. It is to be hoped that the normal procedure of to-day is an extraordinary one, and may revert to the ordinary again in not too distant a future.

All foundry remelting processes are more or less oxidising in character, and hence due allowance is made for losses in those elements easily affected. Silicon and manganese are the two chief objects of attack by the oxygen of the blast, so far as the metal itself is concerned. Using suitable pig-irons rich in manganese cares for that element, and the silicon is calculated out specifically to be certain of the proper result. In the case of sulphur and phosphorus, however, the first is enriched by absorption from the coke used, and phosphorus practically concentrates, as none of it is lost in the reduction of tonnage during melting.

Reduction of Sulphur in the Blast Furnace.

While sulphur is now understood to be less injurious than was formally supposed, for most of the evils attributed to it may be charged to oxidation of the iron through poor melting; yet as present day melting practice is only a striving after perfection in method, with every foundryman falling less or more behind the ideal, the combination of high sulphur with some oxidation of the metal itself becomes an unmitigated nuisance, and leaves a trail of lost castings following it. Hence the elimination of sulphur in cast iron is a very pertinent, timely and practical problem, the first and easiest solution for which lies in the use of high percentages in the mixtures, as above indicated. Another method of sulphur reduction applicable to cast iron prevails in blast-furnace practice, and is efficient because of several factors. First the comparatively higher heat of direct metal, where time is plenty and where in transportation there is considerable jolting. In such a case sulphur and manganese get together, and the compound, readily formed under temperatures so much higher than cupola metal, gets jolted upward under and into the slag, and can be removed before pouring the iron into the casting machine for pigs. Remarkable sulphur reductions are the result of such a procedure. Unfortunately, however, the foundry has neither the temperature nor time available, nor does the foundryman wish to jolt his molten metal during transport.

The Electric Furnace for Desulphurising.

The second method for desulphurising cast iron, and unquestionably the best one, is treatment of the molten metal by lime additions upon the basic hearth of the electric furnace. Practically all the sulphur can be removed from cast iron in this way, if time and expense be a secondary consideration. "Duplexing," or running cupola metal into the electric furnace for additional superheating, with possible deoxidation, and reduction in sulphur as desired, is now well known in the foundry industry, so that special attention need not be given the subject here. The fact remains, however, that an electric furnace is costly, and hence within the reach of larger concerns only; and furthermore furnace operation costs also, the principal items being current and electrodes. Nothing in the method to be described below should be construed as antagonistic to the electric furnace process, whether straight or by duplexing, but the great majority of foundries find it, and always will find it, impossible to undertake this costly but wonderfully effective method of getting the finest cast iron that can be made at the present day.

Reduction of Sulphur by Chemical Additions.

The latest candidate for foundry favours in regard to sulphur reduction in cast iron is the chemical method. It has long been known that the application of soda or potash on the clean surface of molten cast iron will remove considerable of the sulphur contained. Many foundries have tried this out, but have always given it up because of the irregularity in results and the time consumed. It has remained for Richard Walter, at Dusseldorf, to discover just how to apply soda, or other alkali-earths, so that positive and practical benefits are derived from their use in the way of sulphur reduction in molten cast iron. It was in the little details of this known method that improvement was effected, and an inexpensive and easy way of reducing sulphur to a commercially practicable point evolved. The writer first saw the desulphurisation of a ladle of molten iron by the Walter process—the first practical one in existence at that time—at the Krupp works in Essen, in 1921. On his return to the United States he described the process and gave details before bodies of foundrymen. Since that time half a dozen methods have come into use in Europe and several over here, and there is nothing to hinder any foundryman from making his soda cakes for desulphurisation purposes. Walter, however, found that the most successful application of the chemical method was had by adding small percentages of the alkali-earths, notably barium or magnesium, to a soda and potash base, and this combination he has patented widely over the civilised world. Referring again to the Krupp test observed, the writer took a sample of the metal before applying the desulphuriser, and again another one after the metal was ready to pour into work. On analysis here, the sulphur was found to be 0.14 reduced to 0.095, or 32 per cent. From tapping out to finish of the test six minutes had elapsed, the usual time for contact of the desul-

* A Paper presented to the Cleveland Meeting of the American Foundrymen's Association.

phuriser with the metal being from two and a half minutes to four, depending upon the temperature available.

Difficulties Encountered in Developing Methods.

In developing the method, Walter found that the chief objection to the use of soda-ash on molten iron was that it took too long to melt. The writer had seen cakes of compressed soda-ash sold here for the purpose which have not been satisfactory because of this difficulty. The air films between the individual grains of soda are sufficient insulators to prevent heat passage through the mass, and the result is that such cakes float on the iron and melt but slowly. The first little detail solved by Walter was to melt the soda base to remove all these air films and thus get cakes which would melt very rapidly when thrown on the molten iron. The next thing found was that unless the surface of the molten iron was thoroughly cleaned from the slag floating on it, the reaction would not take place. The alkali simply united with the silica of the slag, and the sulphur was not affected. This meant that a ladle of molten iron has to be skimmed off carefully and fully before the desulphuriser cakes can be thrown on. Obviously, this involves careful cupola practice to run very hot, and thus get a clean separation of iron and slag within the cupola itself. Then, in tapping out, to "bod-up" before the slag begins to run. Again, it is necessary to keep the ladles clean, and most important, to make iron which will not have more slag come to the surface after cleaning off once. Such iron—which is often seen in foundries with poor melting practice—is hopeless of improvement, for the soda-slag greedily attacks the iron slag, and any sulphur absorbed by contact at once returns to the iron. Observations have shown that only the liquid slag of the iron is to be feared specially, as the ladle lining itself is attacked so little in the short time involved that contact with the brick and daubing is negligible. Further, the practice of throwing a handful of sand on the clean surface of the metal, whether before applying the desulphuriser, during the reaction, or just before removing the soda-slag, must not be resorted to, as it will vitiate the effect at once.

Removing the Slag Formed by the Desulphuriser.

It is, of course, possible to throw the desulphuriser cakes into the bottom of the ladle and let the stream of molten metal flow over them as the ladle fills up. This saves a lot of time, and is to be recommended where provisions are made to keep out slag absolutely; and further, where the iron is so hot that chances for soda-slag mixed up in the iron when pouring off the metal are not taken. This soda-slag of the reaction is an exceedingly thin and penetrating material. If allowed to run into the moulds with the iron, the castings are doomed. Hence, the next little detail worked out by Walter was to provide for an effective way of removing this thin slag. He does it by scattering a highly refractory absorbent material upon the thin slag, and thus solidifies it, whence it can be broken up with the rod or skimmer and easily removed. The best material is air-slacked lime, which is a fluffy powder that sucks the thin slag into it and solidifies in lumps, so that the surface of the ladle after application of about a cigar-box full of lime to a ton of metal looks like a clear ocean of liquid, clean metal, with floating islands of chalk dotted over the surface. Tilting the ladle and using the skimmer makes a clean job, and the metal may now be poured. If, however, the metal is still very hot and it is desired to repeat the operation, this can be done and another reduction in sulphur effected. Normally the reduction is 40 per cent., so that sulphur 0.18 should be cut down to 0.115 or less. A second application would normally reduce this further to 0.07, or less. So that the result is a very valuable one considering the beneficiation of the metal achieved.

It may be stated that, if desired, this powdered lime can be merely thrown about the lip of the ladle, and the slag thus consolidated only about the pouring point and effectively holding back the thin soda slag behind. Preferably, however, the slag ought to be removed *in toto*, as there is always a chance of stray slag being about, and this means a reversal of action.

Amount of Desulphurisation Necessary.

Walter found the quantity of material to be used for results that are good and at the same time not too costly, is half of 1 per cent. of the weight of the iron to be treated. That is to say, ten pounds for every ton of metal for every treatment given. In many cases it is possible to make two applications, and wind up with metal still sufficiently hot to pour successfully.

Other Chemical Combinations.

The imitations of the original Walter development have embraced some curious combinations of chemicals. The use of potash and soda, with some barium and magnesium salts, when melted and poured into cakes, yield a material which will melt on the molten iron quietly, without fumes or flame, and throw off no gases to injure the respiratory organs of the operatives. In one imitation, a proportion of caustic soda is added to the soda base, and this is claimed by those who have used it to be very disagreeable by reason of the highly caustic and irritating particles thrown off when struck by white hot molten metal. Again, chemicals other than those of the alkali groups when thus used have only a part of the action in removing sulphur. Indeed, probably all the materials offered to the foundryman give a certain effect at the first few moments of contact, but this effect is only sustained where the alkalies are used.

Reaction Extends Throughout the Ladle.

A further very interesting fact is that the reaction of the desulphuriser placed on the surface of the metal in the ladle extends promptly through the whole mass. Samples for analysis have been repeatedly taken from the top, middle and bottom of a ladle of desulphurised iron and practically identical amounts of sulphur found. Again, many tests have been made to observe the action of the alkalies on any gases that might be dissolved in the metal, and in every case these have been found materially reduced, showing that there is a slight tendency to deoxidation. These investigations are being conducted in Europe, and the data obtained will eventually be published.

Probable Application in America.

The method that will probably be used in America in applying desulphurisers to molten iron is one that is already giving excellent practical results in some European foundries. It consists in arranging for a slag-removing cupola spout, either for all the metal tapped out, or having such a spout in addition to the regular one, and specially for the purpose in hand where it is desired to desulphurise only the metal for special lines of castings. This special spout has a trap arrangement close to the tap-hole, the molten metal passing under a firebrick bridge which retains the slag that may come with the metal and lets it flow over a notch in the side. It is a spout often used where the stream of iron flows continuously. In case of stopping-up, if the basin of molten iron under the firebrick arch is apt to freeze up, this metal has to be tapped away by special tap hole. The stream of metal from this special spout is allowed to run into a large storage ladle which has a partition at the lip which runs almost to the ladle bottom. In other words, the ladle is in effect a "tea-pot" arrangement perfectly familiar to all foundrymen. When full of metal the bulk of the molten iron is in the large chamber with but a little in the "spout" portion of the ladle. On the large surface there is placed sufficient desulphuriser to start the reaction, and this is added to from time to time as the iron keeps flowing into the ladle and as metal is poured off into the carrying ladle. The proportion of desulphuriser added is aimed to be the standard half of 1 per cent. of the molten metal to be treated. When operating in this way, every so often the adding of the cakes is stopped, and air-slacked lime is thrown on to collect the spent soda-slag; and this is removed just as in the case of ladle treatment. There need be no cessation of the stream of metal entering the ladle nor the taking away of the corresponding amount by tilting it into carrier ladles. The object of the method is to create as little interference with the shop routine as possible.

Where all the molten iron is to be desulphurised, the apparatus can be of considerable size, so that

it in effect serves as a forehearth for the cupola. This will undoubtedly be the future development, for with a continuous stream of iron from the cupola, and this carefully cleared from slag automatically, with a large mixing ladle to serve for storage and desulphurisation action, there will be no necessity for holding metal in the cupola at all, and the tuyeres can be lowered considerably while still allowing for regular slagging-off. Coke is thus saved and a better chance for mixing given the metal than is possible within the cupola.

It is a curious fact that whenever a need presents itself in an acute way, a remedy comes to hand. Foundrymen have looked with misgiving at the evident dying out of the skilled moulder, but the mechanical equipment devised seem to have replaced him fairly well without the promised disaster. So also in the case of the rising sulphur in our scrap, we are given two very effective ways of correcting the difficulty, and the method above described seems amply to fill the requirements of the foundryman unable to purchase the electric furnace, with its still greater possibilities.

A Note on Foundry Costing.

By E. T. GIDDINS.

In the present days of cut prices and minimum profits it is essential that the absolute cost of production should be established, as far as possible, for the guidance of the foundry manager, when taking out estimates and preparing quotations.

A costing system need not be an elaborate, complicated mechanism, but the costs accountant must have access to every possible record of production and expense.

The first and most essential detail to be enforced is that castings must bear some individual distinguishing number. It is remarkable that some founders continue to lose large sums in hunting certain castings and comparing them with patterns to establish their identity.

The most satisfactory method is to cast-in numerals, or to stamp castings immediately they are knocked out of their boxes.

In the foundry the actual moulders or coremakers can be clocked on and off, as he brings a pattern from the pattern store or returns with it. This is a more reliable method than allowing the men to mark up time on their own cards. The foreman can also record each job given to his men each day, and this will act as a check. The actual moulding time is by this means established.

Cupola Costs.

The furnace or cupola can bear all costs appertaining to itself, and should be calculated on a hundredweight basis as cost of metal into moulds. In this cost will be included power, lighting, unskilled labour, rent of a section of foundry space, supervision and laboratory. This figure can be calculated monthly, and it is well to charge cost of raw materials on the average price of scrap, turnings, coke, etc., over the period. The ideal method is for the storekeeper to check quantities received and used, graphically, in which case the price of the oldest materials carried is the best one for costing purposes.

Indirect Moulding Costs.

The cost of foundry materials, unskilled labour, power, lighting, rent, cranes, etc., can be charged as an oncost at a certain figure per hundredweight of castings leaving the foundry. These charges bear a closer relationship to the weight of a piece of work than the time of the moulders employed on a particular job.

Drying Stove Costs.

The annealing and drying stove can also be costed in the same way, but applied apart from foundry oncost; the reason being that methods of heating may be changed, or the price of coal vary considerably. Here again it will be seen that an oncost based upon the weight of a casting is fairer than when based upon the moulders' time, for a casting may be large and comparatively simple to mould, yet would possibly occupy most of the annealing stove, in which case it naturally must bear this charge in proportion to the room occupied, and for this the weight is a good enough indication.

Dressing Shop.

In the dressing shop, cards ruled with the hours and quarters can be issued to all men with the exception of labourers who are employed on innumerable jobs throughout the day. At this point it is particularly necessary that the foreman should see each man mark down the job number in the quarter-hour at which he commences, and again when the casting, or set of castings, is complete. Similar casts should be prepared for the sandblast men, but with larger spaces in which would record collection of job numbers put into the chamber together.

Dressing Shop Oncosts.

Supervision, power, lighting, saws, cutters, rent, are better if calculated on an hour's percentage charge, added to the dressers' time on each job. The total can be established, say, every three months. A twelfth of this total divided by the number of hours' dressing for all men in the shop would give the necessary percentage charge to be added to the dressers' times against each job number.

Castings with many risers, cores and intricacies would in this way be debited with a larger amount in proportion to the time taken to dress them, and this time would have a much closer relationship to the cost of power, for saws, pneumatic tools, etc., and supervision, than the weight would have.

So far we have established direct costs for metal and moulding with oncost on weight for foundry expenses and stoves, also a direct cost for dressing, with an oncost on dressers' time for dressing shop expenses.

(1) Cost of metal at ..... per cwt.
(2) Cost of moulding at ..... per hour.
(3) Cost of foundry expenditures at per cwt.
(4) Cost of stoves at ..... per cwt.
(5) Cost of dressing at ..... per hour.
(6) Cost of dressing expenses at ..... per hour.

Pattern Shop and General Expenses.

The pattern shop can charge time against each job sheet issued to it, together with the necessary percentage to cover its overhead charges, based upon the total hours worked by all men in the shop.

General expenses are often added as a rough estimate, but there is no reason why these cannot be calculated to within reasonably fine limits. The office expenses, salaries, insurance, transport, travellers' expenses, are all items which can be ascertained by resource to available records. Where the plant is all the property of the firm depreciation will enter largely into this figure, and it is as well to have this estimated by an architect or builder whose knowledge can be relied upon. The last item is interest (not profit) on capital or on debentures; here again we have a figure which is readily obtained.

With these expenses totalled for the half-year, it is easy to calculate the weekly amount incurred by the firm. Divide this figure by the output per week in tons or hundredweights, and the result will be an oncost on the weight of each casting at a figure per ton or hundredweight as the case may be.

General expenses are often added as a large percentage on the *works cost*, and perhaps quite rightly, but this method has one serious objection in the fact that the figure remains the same for increased or diminished output with obviously unsatisfactory results.

The foregoing remarks are merely a skeleton of the interesting work of costing, and will serve as a guide to those wishing to improve their present methods by securing data for estimating purposes.

Other Points.

No item of profit should enter the cost accounts at any point. Job sheets must be issued for each *kind* of casting on a customer's order, not the whole order, unless a further figure is used (and applied to the castings) for each item.

The practice of taking out a job sheet for a whole order and charging up time to that number is unsatisfactory, and absolutely useless when an inquiry arrives for one item on any such order.

The true secret of costing is common sense, and with regard to statistics a desire to obtain the truth.

British Foundry Practice: Ferrous and Non-Ferrous.*

By Percy Longmuir, D.Met.

British foundry practice to-day owes a considerable debt to the early effective pioneering work of Professor Turner, and his investigations of the action of silicon upon cast iron† not only gave a definite impetus to foundry development, but had the further valuable incentive of turning many other workers towards systematic investigation of cast metals.

The comprehensive work of Hadfield, beginning with alloys of iron and manganese‡ and continued through many other possible combinations, has led to vast extensions in the field of ferrous metallurgy, and consequential development of steel-foundry practice.

Arnold, in his classical research on the "Influence of Carbon on Iron,"§ published in 1895, paved the way for definite studies of constitution which have since been developed and advanced by many European workers to the profit of metallurgy in general and foundry science in particular. The reports of the Alloys Research Committee of the Institution of Mechanical Engineers, the proceedings of the Iron and Steel Institute, the Institution of British Foundrymen, the Institute of Metals and many other live organisations, all contain definite evidence of substantial forward movement. In addition, the Universities of Britain are doing particularly good work in advancing the outposts of the known into the unknown.

In his 1901 Paper before the A.F.A., "The Relation of the Laboratory to the Foundry," the author concluded with:—

"The future of all foundry work depends upon the development of scientific methods, and from the foothold these methods have already obtained we see the dawn of an era which will be distinguished by a great advance of the whole foundry industry."

The intervening 22 years have shown that the "foothold" then indicated has become firmly established and scientific method has become a factor in all the more important British foundries. Undoubtedly the success of this establishment is due to the fact that it has progressed hand in hand with practice, thereby resulting in the development of the latter.

Chemical and metallographical laboratories have proved of high value to practice. Equally, on the other hand, experienced practice of the foundry floor and the melting platform have proved invaluable to the laboratories.

Whilst this united development has taken place it can but be admitted that each forward step has simply increased the extent of the unknown.

It must be remembered that 22 years ago engineering practice was receiving more attention than foundry practice. Therefore the foundry had a certain leeway to make up. During this period of making up, engineering practice has not been stationary. Therefore the foundry has not only had to make up lost time, but also to make the further endeavour to overtake present development in industries whose foundation depends upon a supply of reliable castings. The extent of this achievement has been admirably shown in Mr. Cook's exchange Paper of last year.

* This Paper, of which the following is an abstract, is one of a series on foundry problems being exchanged between the Institution of British Foundrymen and the American Foundrymen's Association. The first, prepared by George K. Elliott of the American Foundrymen's Association, was presented at the 1921 meeting of the Institution of British Foundrymen. The second was presented in person at Rochester, N.Y., by F. J. Cook, Past President of the Institution of British Foundrymen. Prof. Enrique Touceda presented the third exchange Paper before the British Society in 1922. The author of this, the fourth exchange Paper, is one of the foremost figures in the British foundry industry. He is a Past President of the Institution of British Foundrymen and director of the British Cast Iron Research Association.

† Journal of the Chemical Society, 1885.

‡ Manganese in its application to Metallurgy—The Institution of Civil Engineers, February 28, 1888.

§ Institution of Civil Engineers, Vol. CXXIII.

Grey Cast Iron.

The range of iron ores available to the blast furnaces together with the range in practice of the furnaces affords the British ironfounder a wide choice of pig-iron. This choice can be supplemented by varying additions of mild steel and ferro-alloys, and therefore a very wide range in product is possible.

The extent of the studies devoted to this product is well shown in the proceedings of the Institution of British Foundrymen. Not only is the range in composition great, but equally so is the type of casting. The development of high-speed internal-combustion engines has created a series of exceedingly intricate castings, and the author has unique opportunities of seeing how admirably the founder is meeting these difficulties. In weight alone the range is equally great; Mr. Matt Riddell of Falkirk will successfully reproduce an ordinary tree leaf in cast iron, using the leaf as a pattern. The Brightside Foundry and Engineering Company, Sheffield, produces castings such as ingot moulds weighing 106 tons.

Advantages and disadvantages of the iron-melting cupola were well drawn in Mr. Elliott's exchange Paper before the Institution of British Foundrymen in 1921. However, the ruling factor of cost supplemented by the fact of the general efficiency of the cupola-melted products will require much consideration before the adoption of the duplex furnace process.

In Britain, work is being carried out in the direction on the one hand of increasing cupola efficiency, and on the other of studies in hearth furnaces, including coal, oil and gas firing. It is in one of these directions that future economic development of melting for grey iron and alloyed cast irons will take place.

Malleable Cast Iron.

In British practice "white heart" predominates over "black heart" so far as quantity is concerned. A good range of white, semi-mottled and mottled pig-irons is available. Many of the furnaces also supply "refined" pig-irons. When an open-hearth gas-fired furnace is the melting medium, "refining" of the bath is permissible. Crucible melting is still largely followed, especially in the Midland area, but bulk work is generally from cupola-melted metal. Coal-fired reverberatory or gas-fired open-hearth furnaces are utilised, and the development of the industry points to the growing use of the latter.

Representative melting practice is shown in the following table:—

Method of Melting.

	Charge. Per cent.	Crucible. Per cent.	Cupola. Per cent.	Coal-fired Reverbera-tory. Per cent.	Gas-fired Open-hearth. Per cent.
Carbon ..	3.5	3.4	3.4	3.2	3.2
Silicon ..	0.85	0.82	0.75	0.65	0.70
Manganese	0.20	0.10	0.10	0.10	0.10
Sulphur ..	0.25	0.30	0.31	0.27	0.26
Phosphorus	0.05	0.05	0.05	0.05	0.05

Average commercial castings give a maximum stress of from 20 to 28 tons per sq. in., with elongations of from 2 to 6 per cent. on 2 in. and reduction of area of from 2 to 8 per cent. Cold bending tests on ½-in. square bars range from 45 to 90 deg. A series of commercial castings of Scottish origin tested by the author gave the following results:—Analysis: Silicon, 0.65; manganese, 0.15; sulphur, 0.30; and phosphorus, 0.04 per cent. The maximum stress in tons per sq. in. was 27.0, the elongation on 2 in. was 5.7 per cent., and the reduction of area was 10 per cent.

In the field of British malleable cast iron Hatfield has done most valuable pioneering work. Reference should also be made to some promising work by Royston in 1897. Royston's early work apparently lay in the direction of an endeavour to obtain quick, if not instantaneous, decomposition

of the hard carbides, and thereby shorten the annealing time. To-day this idea is well worth investigation along the lines of determining critical ranges in the near vicinity of the solidification range. A certain amount has been done in the way of laboratory experimental work, and in 1904 the author obtained this quick decomposition and resultant precipitation of temper carbon by heating to temperatures near the fusion range. However, investigation on practical lines is required in which limiting foundry conditions, influence of mass, change in section and contour of casting and resultant possibilities are included.

In view of the masterly Paper of Professor Touceda, the present author feels much diffidence in dealing with malleable cast iron. However, it cannot be denied that British malleable iron practice offers a most promising field for research.

In closing this note on malleable cast iron it is permissible to refer to a casting recently selected at random in a British foundry. Ductility under a striking hammer was so evident that analyses and metallographical examinations were made. The analysis showed total carbon, 0.03; graphitic carbon, nil; silicon, 0.52; manganese, 0.17; sulphur, 0.292; and phosphorus, 0.049 per cent. Microscopical examination showed structure to be built up mainly of ferrite with involved iron and manganese sulphides.

Steel Castings.

Systematic steel casting in foundries began in Britain about 1856, and Vickers was one of the first successful workers in this direction. He was followed by many workers, among whom may be mentioned Attwood, Rogerson, Spencer and Osborn. The Paris Exhibition of 1878 apparently gave an impetus to steel founding in the exhibit of the Terre Noire Co. Early developments were necessarily of the "trial" order and naturally many errors had to be eliminated. In this patient, persistent work lies the foundation of the steel-casting industry of to-day. This early practical work, followed by the researches of Hadfield, Stead, Arnold, McWilliam and many other workers not only opened up scientific possibilities, but further led to united practical and scientific attack on the problem of steel casting.

In modern commercial practice, crucible melting is followed to a limited extent only. The bulk of the castings are produced from acid and basic open-hearth furnaces, bottom- or surface-blown converters. The electric furnace is gaining ground in steel-foundry practice, and, by virtue of its elasticity, offers an excellent medium for the production of special alloy steel castings.

Generally speaking, the metallurgy of steel castings has as its first concern the determination of the most suitable composition to meet the required mechanical properties. Secondly, the process, whether open-hearth, surface-blown or electric, should finish with a bath of "killed," *i.e.*, dead melted steel. This is achieved by judicious conduct of process and judicious use of deoxidisers. In regard to process, it is possible to produce high purity with little or no addition. The following pure iron casting, analysing carbon 0.04, silicon 0.02, manganese 0.07, sulphur 0.02, and phosphorus 0.02 per cent., was crucible melted and killed with a trace of aluminium:—

	Yield Point. Tons.	Max. Stress. Tons.	Elongation. Per cent. on 2 in.	Reduction area. Per cent.
As cast	10.7	19.8	30	39
Annealed.. ..	9.1	19.2	46	65

Purity of this type is hardly commercial, but, at the same time, the results give the properties of pure iron in the cast and treated condition.

Additions of carbon to such an iron would progressively stiffen it, but experience has shown that carbon alone is not sufficient, at any rate so far as castings are concerned. For this reason the two most familiar deoxidisers—silicon and manganese—are, either singly or combined, added to leave a predetermined excess in the finished steel.

A steel casting containing carbon 0.34, silicon 0.15, manganese 1.58, sulphur 0.06, and phosphorus 0.06 per cent. gave the following values:—

	Yield Point Tons sq. in.	Maximum Stress. Tons per sq. in.	Elongation per cent. on 2 ins.	Reduction of area. Per cent.	Bending Angle (degrees).
As cast..	23.1	35.8	8	9	33
Annealed	17.3	32.1	21	28	180

The influence of special elements is naturally a very large field, and the results shown in Table I. are given as representing only a small section of this field.

TABLE I.—*Nickel Steels in the Cast Condition Reheated to and Cooled from 800 degrees Cent.**

Contents of			Yield Point tons per sq. in.	Maximum Stress tons per sq. in.	Elongation per cent. on 1.75 ins.	Reduction of area Per cent.
Nickel	Carbon.	Manganese.				
Nil	0.47	0.95	19.24	38.49	15.42	16.26
1.20	0.48	0.79	22.07	43.23	14.28	14.88
2.15	0.47	0.86	25.79	42.84	17.70	23.51
4.25	0.40	0.82	28.11	43.49	13.10	17.94
4.95	0.42	1.03	36.00	56.09	14.28	24.43
6.42	0.52	0.92	27.13	57.51	6.20	8.42
7.95	0.43	0.79	41.47	74.03	4.50	5.68
12.22	0.41	0.85	39.85	71.19	6.20	6.88
15.98	0.45	0.83	31.59	76.55	4.00	4.21
19.91	0.41	0.96	17.94	29.69	14.30	19.05

* Seventh Report to the Alloys Research Committee, Iron, Nickel Manganese Carbon, Alloys. Carpenter, Hadfield & Longmuir.

Characteristics Common to all Castings.

There are many features common to all grades of castings. Liquid shrinkage, solid contraction and its resultant warping are familiar to all founders, varying in intensity according to the type of metal or alloy handled. At the moment it is impossible to touch on these interesting features, but there is one common characteristic on which the author would like to dwell for a few moments. This is the influence of varying casting temperature on the physical properties of cast metals and alloys.

Some years ago, hard practical experience in the production of high-pressure fittings led to the recognition that for a given metal or alloy one range of pouring temperature would produce a pressure-tight casting, whilst another pouring temperature from the same ladle would result in a porous casting.

Grey cast iron having an analysis of CC, 0.52; Gr, 3.4; Si, 1.78; Mn, 0.28; S, 0.04; and P, 0.27 per cent., gave 9.7, 14.1 and 10.6 tons per sq. in. Maximum stress at 1,400, 1,350, and 1,245 casting temperature respectively.

For malleable cast iron the results were as follow:—

Casting temperature deg. C.	As Cast Max. Stress tons per sq. in.	Annealed Max. Stress tons per sq. in.	Heated to 1,000 deg. C. slowly cooled.
1320	10.7	20.6	18.6
1230	15.9	29.2	24.0
1120	12.1	26.5	21.6

Annealed steel castings, containing C, 0.29; Si, 0.07; Mn, 0.16; S, 0.07; and P, 0.06 per cent., showed the following results:—

Casting temperature.	Maximum Stress tons per sq. in.	Elongation per cent. on 2 ins.
High	24.2	9.5
Fair	27.2	24.0
Medium	27.0	12.5
Low	25.5	8.0

Although many actual casting temperatures have been determined, only comparatively few have been quoted in terms of degrees Cent. This for the reason that there cannot possibly be a constant "fair" casting temperature for any given alloy to cover every type of casting made in that alloy. Correct casting temperature must necessarily vary with the contour and section of the castings, and it is in this direction where trained foundry judgment can exercise its skill to the advantage of the product.

Acieries de Rombas.—This French concern reports that the company during 1922 showed considerably more activity than it did in 1921. The iron-ore output rose from 717,250 tons to 1,100,000 tons, and the output of basic Bessemer pig-iron and direct castings increased from 243,840, tons to 430,000 tons. The output of steel ingots also showed an improvement. Although the financial results last year were better than they were in 1921 there is still a loss of some 27,500,000 fcs. (say, £393,000) on last year's working.

XUM

Trade Talk.

THE WORKS of the Masta Steel Company, Limited, Sheffield, are being offered for sale by private treaty.

THE P. & O. COMPANY have recently placed orders with Harland & Wolff for the construction at Greenock of two passenger steamers of 15,200 tons. A third ship of the same type will be constructed by R. & W. Hawthorn, Leslie & Company, at Newcastle. The Greenock yard has also an order for a 10,000-ton passenger steamer.

MR. SIDNEY SIMPSON, who was formerly assistant to the engineer and manager of the Yorkshire Electric Power Company, and latterly associated with Mr. J. E. Schofield, Bradford, and Mark Shaw & Sons, Limited, Milnsbridge Ironworks, Huddersfield, has now commenced practice as a consulting engineer, with offices at 9, Market Street, Bradford.

THE "PNEULEC" MACHINE COMPANY, LIMITED, who are well known as makers of moulding machines, have just completed their new works in Mafeking Road, Smethwick (Telephone No. 444 Smethwick), and are considerably extending their manufactures, which will now include the production of general foundry plant, and the furnishing of all foundry commodities.

CHILLED CASTINGS, LIMITED, 27, Mincing Lane, London, E.C.3, have acquired the Griffin rights for Great Britain and the Colonies which were formerly held by the British Griffin Chilled Iron & Steel Company, Limited (in liquidation). The Company will continue the manufacture of "Griffin" chilled wheels, chilled and grain rolls and chilled castings. Mr. H. C. Marriott, managing director, was for over twenty years with the British Griffin Company. The new directors are Mr. S. Weiss and Mr. P. Ropsy.

THE STAVELEY COAL & IRON COMPANY, LIMITED, near Chesterfield, are supplying the Burton-on-Trent Corporation with the cast-iron pipes and special castings for a 27-in. sewage main. This contract involves the manufacture of about 900 tons of 27-in. cast-iron pipes and special castings, to the value of £9,643. The Staveley Coal & Iron Company, Limited, whose London office is at 34, Victoria Street, Westminster, S.W., are also supplying cast-iron tube segments for the Hampstead line and Hendon to Edgware Underground extensions.

MEETINGS of the shareholders and creditors of Cubitts' Engineering Company, Limited, are to be held to consider the reorganisation of the company. According to the company's statement of affairs as at February 28 last, the liabilities were stated to amount to £257,110, and the assets of the company were put down at £401,761, thus showing an estimated surplus after meeting the liabilities of £144,651. In order to provide for the continuation of the business it is necessary to raise funds for the purpose of dealing with the company's preferential indebtedness and of providing further working capital. It is therefore proposed to create £150,000 7 per cent. second mortgage debenture stock (of which £53,153 is to be issued forthwith).

Personal.

HIS ROYAL HIGHNESS THE PRINCE OF WALES, who honoured the Institution of Mining Engineers and the Institution of Mining and Metallurgy with his presence at their combined dinner at the Guildhall, London, in November last, has graciously accepted enrolment as an honorary member of both Institutions.

THE SERVICES of Mr. J. T. Batey, managing director of R. & W. Hawthorn, Leslie & Company's shipyard, Hebburn, to ambulance work in the town and shipyard, and the fact that in London on Friday last he was invested with the Order of the Knight of Grace of St. John of Jerusalem and England, were recognised on Saturday last by a presentation in St. Andrew's Institute, Hebburn. Mr. Batey is president of the local St. John Brigade and also of the Shipyard Ambulance Corps.

Wills.

ALLEN, A. E., of Sedgley Road, West Tipton, Staffs., chairman of W. G. Allen & Sons (Tipton), Limited £25,028

LATHE, CHARLES, J.P., of Summerhill House, Coseley, Bilston, Staffs., iron-founder, lately chairman of Charles Lathe & Company, Limited, of Tipton £41,681

MOORE, W., Abbeyfield Road, Sheffield, steel manufacturer, of the South Yorkshire Steel Works £13,623

MUSHET, H. C. B., connected with Samuel Osborn & Company, Limited, Clyde Steel Works, the Wicker, Sheffield... £2,979

Company News.

Stanton Ironworks Company, Limited.—Final dividend, 6 per cent., free of tax.

Summerlee Iron Company, Limited.—Dividend, 7 per cent., actual, tax free; carried forward, £16,113.

North Lonsdale Iron & Steel Company, Limited.—No interim dividend will be paid for half-year to April 30, 1923.

Clayton, Jackson & Company, Limited, Hull.—Capital £3,000. Engineers, etc. Directors: T. W. Clayton and G. F. Jackson.

Chilled Castings, Limited, 27, Mincing Lane, London, E.C.—Capital £1,000. Directors: S. Weiss, P. Ropsy and H. C. Marriott (secretary).

A. Melbourne & Company, Limited, 10, Throgmorton Avenue, London, E.C.—Capital £100 in £1 shares. Engineers. Directors: F. G. Philpott and T. Chadwick.

Pather Iron & Steel Company, Limited.—Dividend, 1s. per share for year; transferred from special reserve account, £12,000; depreciation, £1,000; carried forward, £3,470.

Shaylor & Hudson, Limited, 209B, Balsall Heath Road, Birmingham.—Capital £5,000 in £1 shares, to acquire the business of a brassfounder carried on by W. Shaylor as "W. Shaylor & Son."

H. Shore & Company, Limited, 106, Cleethorpe Road, Grimsby.—Capital £500 in 5s. shares. Iron, steel and metal merchants. Directors: H. Shore (managing director), and E. J. Bascomb. Secretary: H. Shore.

Hopyard Foundries, Limited, Siddons Road, Coseley, Staffs.—Capital £5,000 in £1 shares, to acquire the business now carried on by the Hopyard Foundries Company, Limited (in voluntary liquidation), and by the liquidator thereof.

Blight & White, Limited, Tweedside Place, Stonehouse, Plymouth.—Capital £10,000 in £5 shares. Constructional engineers and iron and steel merchants. Directors: Mrs. F. M. Blight (permanent), F. G. White and B. J. Woodrow.

Whessoe Foundry & Engineering Company, Limited.—Profit, £36,430; depreciation on land, buildings, etc., £6,617; written off patents, £1,293; net profit, £28,518; brought forward, £10,727; available for distribution, £39,245; dividend, 10 per cent. (free of tax), £20,000; bonus, 5 per cent. (free of tax), £10,000; carried forward, £9,245.

Open Contracts.

Aberdeen, June 8-22.—Manufacture and delivery of about three miles of 4-ft. dia. cast-iron or mild steel (lap-welded) pipes and specials, for the Corporation. The Water Engineer's Office, 41½, Union Street, Aberdeen. (Fee, £5, returnable.)

Buenos Aires.—A firm in Buenos Aires, who have secured a contract from the Argentine Government for sewerage and water supply schemes, require quotations for cast-iron pipes. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Gazette.

A RECEIVING ORDER has been issued in the case of Mr. L. de Antiquis, 12, Wilton Grove, and 170, High Street, Colliers Wood, Merton, iron and metal merchant. Examination C.C., Croydon, June 20, at 11.

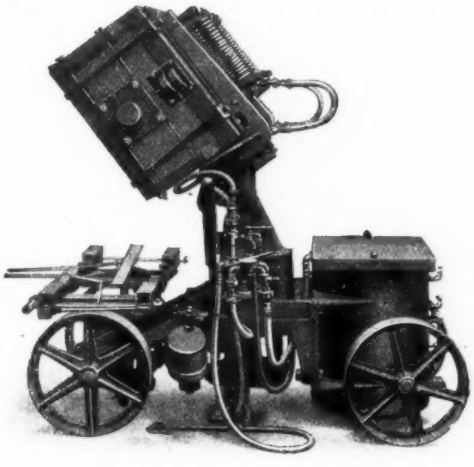
THE PARTNERSHIP hitherto subsisting under the style of W. G. Brown & Sons, 220, Old Shettleston Road, Glasgow, engineers, has been dissolved by retiral of Mr. W. G. Brown. Debts by Mr. T. Brown, who continues the business.

A RECEIVING ORDER has been issued in the case of Mr. W. H. Pease, Hastings House, Norfolk Street, Strand, and Welwyn Garden City, engineer and governing director. Examination, Bankruptcy Court, July 3, at 11.

THE PARTNERSHIP heretofore subsisting between Messrs. J. Clark, G. H. Clark, G. Clark, J. E. Clark, and A. E. Clark, brassfounders, etc., 49 and 51, Chester Street, Birkenhead, under the style of George Clark & Sons, has been dissolved, so far as concerns Mr. G. H. Clark.

MR. W. H. TUCKER, Bryn Road, Swansea, lately carrying on business under the style of Tucker, Matthews & Company, metal merchants, who underwent his public examination recently, said the cause of his failure, with a deficiency of £2,983, was insufficient capital, borrowing money at high rates of interest, and losses on contracts. The examination was provisionally closed.

MACNAB & CO.



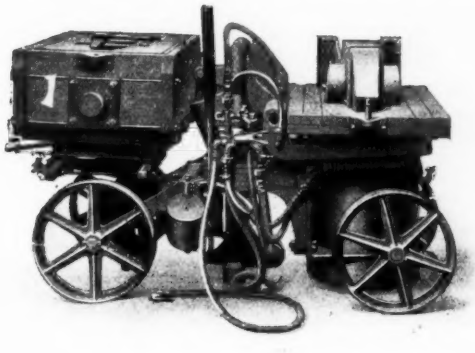
Box and Mould—after being Rammed—
in position of being Rolled over

Tabor Patent
Portable
Combination
Shockless Jarring-
Roll - over
AND
Pattern - Drawing

MOULDING MACHINE

Capacities and Dimensions furnished upon application.

We make various models and sizes for all types of machine moulding, according to class of work and numbers.



The Finished Mould—showing Pattern after being drawn.

Send us Drawings of your work for Specific Expert Advice, according to your conditions and quantities.

56/8, Eagle Street, Southampton Row, London, W.C.1.

Works : TOTTENHAM, LONDON, N.17.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Movements in the Cleveland iron market during the past week have again disclosed a weakening tendency in values, the home demand continuing quiet, while the volume of inquiry on export account remains restricted pending a settlement of the Ruhr difficulty. The reluctance of buyers in existing circumstances may be explained by a widespread impression that pig-iron prices have not yet touched bottom levels, an idea, doubtless encouraged by the fact that Scotch and Midland foundry qualities are cheaper than Cleveland. In the meantime, makers' current contracts are running out, and accumulations in the yards point urgently to the necessity of fresh business. But stocks in hand are still comparatively small, and with output on a relatively restricted scale, makers are not disposed to cut severely, particularly as only a moderate expansion of foreign demand would speedily reverse the whole position. Moreover, fuel costs are still extremely high, and the easier position as regards export coke is not reflected in the price to the home industries. Prices, consequently, showed a weaker tendency, the standard No. 3 G.M.B. freely offering at 117s. 6d. per ton, and No. 1, which is still very scarce, while recently quoted at 130s., could be bought at about 129s. No. 4 foundry was irregular at 115s., and No. 4 forge was quite nominal in the region of 112s. 6d. per ton

Hematite, which has been a very steady market for some weeks, has at last given way, owing, in the main, to the prolonged slackness of Continental demand. At Middlesbrough last week East Coast mixed numbers could be negotiated without difficulty at 120s., but this week this figure has been cut to 117s. 6d., and mixed numbers are none too strong at that. The premium on No. 1 was unchanged at 1s. per ton. The fall in values may bring a renewal of foreign inquiry. On the other hand, now that hematite is no cheaper than No. 3, the temporary demand for foundry purposes will no longer obtain. In West Cumberland and North Lancashire there is also a change in prices. Bessemer mixed numbers being offered £6 7s. 6d. per ton delivered at Glasgow and Sheffield, and £6 10s. for export.

MANCHESTER.—In this centre of the foundry trade consumers continue to hold off the market for pig-iron, and business in the local market is consequently negligible in volume. There is no doubt that competition for orders for castings has been very keen for the last three months, and this has led to the cutting down of profits, so that, if the Lancashire ironfounder has in the end, to pay the current prices for pig-iron, his business will bring him no return. Of course, he might increase the consumption of scrap, which is comparatively cheap, but he must have a considerable proportion of pig, and is waiting for the chance of getting it at a reasonable price. Consequently very little business is being done here in foundry iron, for the Midland furnaces are still quoting 105s. to 107s. 6d. per ton as their lowest figures, and merchants ask round £6 delivered in Manchester. With regard to other classes of pig-iron, there is no particular change to report. The price of Scotch No. 3 pig delivered here is about £6 12s. per ton.

THE MIDLANDS.—Markets in the South Staffordshire area are again reported quiet, and, for the present, new business is difficult to negotiate, consumers being disinclined to renew contracts, and there is very little prompt demand. Local deliveries under contracts remain good, however, and as long as this is so apparently makers will remain firm. Prices were, however, weaker. Northants forge being down to 95s., and Derbyshire forge to 100s. Current quotations: Northamptonshire forge, 95s. to 97s. 6d.; No. 3 foundry, 107s. 6d.; Derbyshire forge, 100s. to 102s. 6d.; No. 3 foundry, 107s. 6d. to 110s.

SCOTLAND.—Business in the Glasgow pig-iron market remains restricted, and few new transactions are reported, consumers generally continuing the policy of buying as sparingly as they can, with No. 3 foundry still quoted at 115s. at furnaces. As previously pointed out, it is difficult to see how prices can fall very far unless there is some substantial relief in fuel. Recently there have been inquiries in the market from home consumers for forward delivery, suggesting that in some quarters, at least, the probability that prices will not go much lower is being quietly considered. There is just a shade more inquiry from abroad, but the tonnage involved is small.

Metals.

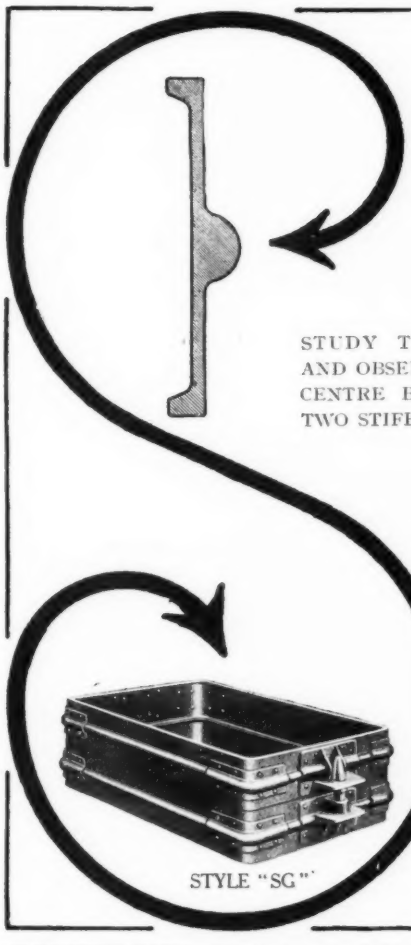
Copper.—With the exception of occasional downward fluctuations values in the standard copper market have been fairly well maintained, and the undercurrent throughout has remained consistently steady. Home consumption continues on a comparatively substantial scale, but buying on Continental account is again restricted by the disturbed political conditions prevailing in industrial Germany. There can be no doubt that earlier in the year buying took place on the theory that the Ruhr question was going to be settled within a reasonable space of time and that the American consumption of copper was going to be maintained at the high level of the closing months of last year and early this. But these anticipations have not been realised, and this has led to a wave of selling from tired holders and speculators. Current quotations:—*Cash*: Wednesday, £65 12s. 6d.; Thursday, £66 10s.; Friday, £66 17s. 6d.; Monday, £67 7s. 6d.; Tuesday, £66 15s.; Wednesday, £66 12s. 6d. *Three Months*: Wednesday, £66 2s. 6d.; Thursday, £67; Friday, £67 10s.; Monday, £68; Tuesday, £67 7s. 6d.; Wednesday, £67 5s.

Tin.—The end of May has brought some renewal of confidence in the market for standard tin, but in the absence of more general support business has been restricted in volume. Home consumption is still below pre-holiday levels, while Continental demand is limited for very obvious reasons. The recovery in values marked towards the close of the week was doubtless stimulated by American buying on a fair scale, and the dealings assumed substantial dimensions, having been temporarily swelled by important repurchases by the short interest, whose commitments are said to be still considerable. After a temporary set-back, and in view of the fact that option contracts have now been pretty well got out of the way, the advent of leading support caused the market to respond quickly, and to be raised even to well above Singapore parity. As in copper, present conditions in tin would suggest that the worst features have been very fully discounted. Current quotations:—*Cash*: Wednesday, £199 15s.; Thursday, £200; Friday, £197; Monday, £197 2s. 6d.; Tuesday, £197 15s.; Wednesday, £196 17s. 6d. *Three Months*: Wednesday, £199 15s.; Thursday, £200; Friday, £197 5s.; Monday, £197 5s.; Tuesday, £197 15s.; Wednesday, £196 17s. 6d.

Spelter.—The position in the market for this metal continues difficult, home consumption having fallen off, while Continental needs have also undergone some reduction under industrial and political troubles. Old stocks in the United States have fallen to the low level of about 9,000 tons, which is rather insignificant considering that the total American deliveries have been for some months past at the rate of well over 45,000 tons a month. This notwithstanding, the American price has dropped a good deal, chiefly due to the weakness on this side. Current quotations:—*Ordinary*: Wednesday, £31 5s.; Thursday, £31 10s.; Friday, £31 5s.; Monday, £31; Tuesday, £30 15s.; Wednesday, £30 12s. 6d.

Lead.—Business in the market for soft foreign pig is quiet and uneventful, but the tone is fairly steady throughout. Consumptive demand is only moderate, and stocks tend to increase. Speculative operations have been on a very restricted scale, due in a measure to the somewhat artificial character of the market. We understand that a fairly large business has been done in this country for export to Russia, which under present conditions is a feature of considerable interest. Current quotations:—*Soft foreign (prompt)*: Wednesday, £25 12s. 6d.; Thursday, £25 15s.; Friday, £25 15s.; Monday, £25 15s.; Tuesday, £25 15s.; Wednesday, £25 15s.

BRITISH DESIGN
THE "AJAX"
BRITISH MANUFACTURE
PNEUMATIC
MOULDING MACHINES
THE JOLT DOES IT
See also our Advertisement Last week and next week.
JOHN MACDONALD & SON, LTD.,
Telegrams: COMPRESSOR GLASGOW
Watt Street, Maryhill, GLASGOW.
Telephone: 61 MARYHILL



Sterling FLASKS

STUDY THIS SECTION, AND OBSERVE THE SOLID CENTRE BEAD AND THE TWO STIFF SAND LEDGES.

ARE NOT PRESSED OUT OF A SHEET..... BUT ARE MADE FROM A HOT ROLLED BAR OF SPECIAL CHANNEL SECTION STEEL.....

THAT IS WHY THE STERLING FLASK IS STRONGER, MORE ACCURATE, MORE DURABLE, AND ALTOGETHER A BETTER FLASK THAN ANY OTHER.

STYLE "SG"

STERLING FOUNDRY SPECIALTIES
LIMITED
Sterling Works, Bedford.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	66 12 6
Three months	67 5 0
Electrolytic	73 10 0
Tough	69 0 0
Best selected	69 0 0
Sheets	100 0 0
India	88 0 0
Wire bars	73 5 0
Do. June	73 5 0
Do. July	73 5 0
Ingot bars	73 5 0
H.C. wire rods	79 0 0
Off. aver., cash, May 6	7 10 6 2/22
Do. 3 mths., May 6	8 4 9 3/22
Do. Settlement, May 6	7 10 0
Do. Electro, May 7	6 18 7 7/11
Do. B.S., May	7 12 9 1/2
Aver. spot price, copper, May	67 9 4½
Do. Electro, May 7	7 5 11
Solid drawn tubes	14d.
Brazed tubes	14d.
Wire	11d.
Yellow metal rods	7½d.
Do. 4x4 Squares	9d.
Do. 4x3 Sheets	10d.

BRASS.

Solid drawn tubes	12¼d.
Brazed tubes	13¾d.
Rods, drawn	11d.
Rods, extruded or rolled	7½d.
Sheets to 10 w.g.	10¾d.
Wire	10½d.
Rolled metal	10¾d.

TIN.

	£ s. d.
Standard cash	196 17 6
Three months	196 17 6
English	197 5 0
Bars	199 0 0
Chinese	196 0 0
Straits	199 15 0
Australian	199 15 0
Eastern	200 10 0
Banca	200 5 0
Off. aver., cash, May 2	0 4 5 13/22
Do. 3 mths., May 2	18 6 23/22
Do. Sttlment, May 2	3 4 10/11
Aver., spot, May	203 2 0½

SPELTER.

	£ s. d.
Ordinary	30 12 6
Remelted	29 0 0
Hard	27 10 0
Electro 99.9	35 10 0
English	31 15 0
India	28 10 0
Prime Western	31 5 0
Zinc dust	47 0 0
Zinc ashes	12 0 0
Off. aver., May	31 0 11 13/22
Aver., spot, May	31 1 3½

LEAD.

	£ s. d.
Soft foreign ppt	25 15 0
English	27 0 0
Off. average, May	25 6 7 1/11
Average, spot, May	25 12 3½

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	40 0 0
Do. V.M. ex whf.	40 0 0
Dutch	36 0 0
Rods	47 0 0
Boiler plates	39 0 0
Battery plates	40 0 0

ANTIMONY.

	£ s. d.
English regulus	30 10 0
Special brands	36 15 0
Chinese	26 10 0
Crude	23 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£13 2 6
75%	£20 17 6
Ferro-vanadium—	
35/40%	16/9 lb. va.
Ferro-molybdenum—	
70/75% c. free	9/3 lb.
Ferro titanium—	
23/25%, carbonless	1/2½ lb.
Ferro-phosphorus, 20/23%	£29
Ferro-tungsten—	
80/85%, carbon free	1/5½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
4/6% car.	£23 10
6/8% car.	£22 10
8/10% car.	£22 0
Ferro-chrome—	
Max. 2% car.	£50 0
Max. 1% car.	£60 0
Max. 0.70% car.	£70 0
67/70%, carbonless	1/6 lb.
Nickel—99%, cubes or pellets	£135 0
Cobalt metal—98/99%	12/- lb.
Aluminium—98/99%	£115
Metallic Chromium—	
96/98%	4/6 lb.
Ferro-manganese (net)—	
76/80%, loose	£18
76/80%, packed	£19
76/80%, export	£20
Metallic manganese—	
94/96%, carbonless	2/- lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£ s. d. 2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.

Rounds and squares under ¾ in. to ¼ in. 3d. lb.

Flats under 1 in. by ¾ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.

Bevels of approved sizes and sections.. 6d. lb.

If in coils.. 3d. lb.

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	4 10 0	
Bundled steel & shrngs.	3 17 6	4 7 6
Mixed iron & steel	4 0 0	4 5 0
Heavy cast iron	4 0 0	4 2 6
Good machinery for foundries	4 5 0	
Cleveland—		
Heavy steel	4 5 0	
Steel turnings	3 10 0	
Cast-iron borings	3 10 0	
Heavy forge	5 1 3	
Bushelled scrap	4 12 6	
Cast-iron scrap	4 0 0	
Lancashire—		
Cast-iron scrap	4 5 0	
Heavy wrought	4 12 6	
Steel turnings	3 12 6	

London — Merchants' buying prices delivered yard.

Copper (clean)	56 0 0
Brass (clean)	36 0 0
Lead (less usual draft)	22 0 0
Tea lead	20 0 0
Zinc	21 0 0
New aluminium cuttings	60 0 0
Braziery copper	48 0 0
Gun metal	48 0 0
Hollow pewter	160 0 0
Shaped black pewter	80 0 0

PIG-IRON.

N. E. Coast—	
Foundry No. 1	129/-
Foundry No. 3	117/6
Forge No. 4	112/6
Mottled	—
Hematite No. 1	118/6
Hematite M/Nos.	117/6
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
Northants forge	95/- to 97/6
„ fdry. No 3	107/6
„ basic	115/-
Derbyshire forge	100/- to 102/6
„ fdry. No. 3	107/6 to 110/-
„ basic	115/-
Scotland—	
Foundry No. 1	120/-
„ No. 3	115/-
Hematite M/Nos.	122/6
Sheffield (d/d district)—	
Derby forge	109/6
„ fdry No. 3	111/- to 113/-
Lincs. forge	110/-
„ foundry No. 3	115/-
„ basic	120/-
E.C. hematite	127/9
W.C. hematite	127/6

All d/d in the district.

Lancashire (d/d eq. Man.) —	
Derby forge	—
„ foundry No. 3	120/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Dalzell, No. 3	132/-
Summerlee, No. 3	132/-
Glengarnock, No. 3	132/-
Gartsherrie, No. 3	132/-
Monkland, No. 3	132/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£ s. d.
Iron—	
Bars (cr.)	£12 to 12 5 0
Angles	12 5 0
Tees to 3 united ins.	12 10 0
Nut and bolt	11 5 0
Hoops	15 0 0
Marked bars (Staffs.)	14 10 0
Gas strip	13 0 0
Bolts and nuts, ¾ in. × 4 in.	20 10 0
Steel—	
Ship plates	10 10 0
Boiler plates	14 0 0
Chequer plates	11 5 0
Angles	10 0 0
Tees	11 0 0
Channels	10 5 0
Joists	10 0 0
Rounds & squares 3 in. to 5½ in.	11 5 0
Rounds under 3 in. to ¾ in.	11 0 0
Flats, over 5 in. wide and up	11 10 0
Flats, 5 in. to 1½ in.	10 15 0
Rails, heavy	10 10 0
Fishplates	14 10 0
Hoops (Staffs.)	12 10 0
Black sheets, 24 g.	14 5 0
Galv. cor. sheets, 24 g.	19 5 0
Galv. fencing wire, 8 g. plain	18 5 0
Rivets, ¾ in. dia.	14 15 0
Billets, soft £8/0/0 to 8	15 0
Billets, hard	10 15 0
Sheet bars £8/10/0 to 8	15 0
Tin bars	9 2 6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 4½
Wire	1 4
Rods	1 3
Tubes	1 6½
Castings	1 1½

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3¼ to 1/9¼
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4¾ to 1/10¾
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6¼ to 2/0¼
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	32.76
No. 2 foundry, Valley	30.00
No. 2 foundry, Birm.	27.00
Basic	29.27
Bessemer	31.27
Malleable	31.77
Grey forge	31.27
Ferro-manganese 80% delivered	130.00
	Cents.
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	45.00
O.-h. billets	45.00
O.-h. sheet bars	45.00
Wire rods	51.00
Iron bars, Phila.	2.82
Steel bars	2.40
Tank plates	2.50
Beams, etc.	2.50
Skelp, grooved steel	2.45
Skelp, sheared steel	2.45
Steel hoops	3.30
Sheets, black, No. 28	3.85
Sheets, galv., No. 28	5.25
Sheets, blue an'l'd, 9&10	3.25
Wire nails	3.00
Plain wire	2.75
Barbed wire, galv.	3.80
Tinplate, 100-lb. box	$5.50

COKE (at ovens).

Welsh foundry	40/- to 45/-
„ furnace	30/- to 35/-
Durham & North. fdy.	47/6
„ furnace	41/6
Other Districts, fndy	47/6
„ furnace	37/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	23/3
„	28×20, „	46/6
„	20×10, „	33/9
„	18¾×14, „	24/1½
C.W.	20×14, „	22/1½
„	28×20, „	44/3
„	20×10, „	30/9
„	18¾×14, „	22/9
Terneplates	28×20, „	43/-

TUBES.

	Up to and incl. 6 in.	
Gas ..	..53⅓%	Tube prices
Water	..48⅓%	are
Steam	..43⅓%	now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	17 10 0
Nail Rods—	
Square, round and flats ..	to 18 0 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32
Blooms—
Single welded .. £10 to £11
Billets—
Single and double welded .. .. £13 to £14
Pig-iron—
Grey, white or mottled £7/6 to £7 12 6
Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.		
May 30	65 12 6	inc.	10/-
„ 31	66 10 0	„	17/6
June 1	66 17 6	„	7/6
„ 4	67 7 6	„	10/-
„ 5	66 15 0	dec.	12/6
„ 6	66 12 6	„	2/6

Electrolytic Copper.

May	30	72 10 0	dec.	10/-
„	31	73 0 0	inc.	10/-
June	1	73 0 0	No change	
„	4	73 10 0	inc.	10/-
„	5	73 10 0	No change	
„	6	73 10 0	„	

Standard Tin (cash).

May	30	193 15 0	inc.	40/-
„	31	200 0 0	„	5/-
June	1	197 0 0	dec.	60/-
„	4	197 2 6	inc.	2/6
„	5	197 15 0	„	12/6
„	6	196 17 6	dec.	17/6

Tin (English ingots).

May	30	200 0 0	inc.	40/-
„	31	200 0 0	No change	
June	1	197 0 0	dec.	60/-
„	4	197 5 0	inc.	5/-
„	5	198 0 0	„	15/-
„	6	197 5 0	dec.	15/-

Zinc Sheets (English).

May	30	40 5 0	No change	
„	31	40 0 0	„	
June	1	40 0 0	„	
„	4	40 0 0	„	
„	5	40 0 0	„	
„	6	40 0 0	„	

Spelter (ordinary).

May	30	31 5 0	inc.	10/-
„	31	31 10 0	„	5/-
June	1	31 5 0	dec.	5/-
„	4	31 0 0	„	5/-
„	5	30 15 0	„	5/-
„	6	30 12 6	„	2/6

Lead (English).

May	30	27 0 0	No change	
„	31	27 0 0	„	
June	1	27 0 0	„	
„	4	27 0 0	„	
„	5	27 0 0	„	
„	6	27 0 0	„	

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE MIXED NUMBERS F.O.T.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	.. 83 11	.. 88 6	.. 94 8	..107 0	..102 6	..101 3	.. 98 9	.. 98 7½	.. 96 6	..104 0	..124 1	..130 0	..106 11½
1916	..133 9	..140 0	..136 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..128 1½	
1917	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6
1918	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6
1919	..122 6	..122 6	..122 6	..122 6	..179 2	..190 0	..197 6	..200 0	..200 0	..200 0	..200 0	..200 0	..171 4
1920	..220 0	..220 0	..240 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..251 8
1921	..240 0	..220 0	..180 0	..180 0	..180 0	..160 0	..160 0	..160 0	..137 0	..127 6	..117 6	..104 6	..162 2
1922	.. 97 6	.. 91 7½	..100 0	.. 98 6	.. 97 1½	.. 94 7	.. 93 6	.. 90 9	.. 89 7	.. 91 10½	.. 93 0	.. 93 2	.. 94 5½

AVERAGE PRICES OF STEEL RAILS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	.. 6 2 6	.. 6 0 0	.. 6 0 0	.. 5 15 6	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 10 0	.. 5 16 3
1909	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 0 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0
1910	.. 5 5 0	.. 5 7 6	.. 5 7 6	.. 5 7 6	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 8 11½
1911	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 13 1½
1912	.. 5 13 1	.. 5 15 0	.. 5 15 0	.. 5 15 7	.. 6 1 6	.. 6 6 3	.. 6 7 6	.. 6 8 0	.. 6 11 3	.. 6 12 6	.. 6 12 6	.. 6 13 9	.. 6 4 4
1913	.. 6 15 0	.. 6 14 4½	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 12 0
1914	.. 6 10 0	.. 6 10 0	.. 6 5 3	.. 6 0 0	.. 6 0 0	.. 6 0 0	.. 5 14 0	.. 6 2 6	.. 6 13 9	.. 6 12 0	.. 6 7 6	.. 6 7 6	.. 6 5 3½
1915	.. 6 10 6	.. 6 17 6	.. 7 5 0	.. 7 12 6	.. 7 12 6	.. 7 17 6	.. 8 17 6	.. 9 2 6	.. 9 2 6	.. 9 2 6	.. 9 7 6	.. 10 10 6	.. 8 6 6½
1916	..10 19 4	..11 0 0	..11 0 0	..10 18 9	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 9 10
1917	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1918	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1919	..10 17 6	..13 7 6	..13 7 6	..13 7 6	..15 0 0	..15 10 0	..16 0 0	..16 10 0	..16 10 0	..16 10 0	..16 10 0	..17 5 0	..14 12 11½
1920	..18 15 0	..19 5 0	..20 7 6	..22 0 0	..23 0 0	..23 0 0	..24 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..22 18 11
1921	..23 5 0	..20 4 0	..18 0 0	..17 0 0	..15 0 0	..15 0 0	..14 0 0	..14 0 0	..14 0 0	..11 12 6	..10 10 0	..10 0 0	..15 4 3
1922	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 0 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 9 4 2

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

IRON & STEEL SCRAP

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE,
MIDDLESBROUGH.

93, HOPE STREET,
GLASGOW.

XUM

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

FOUNDRY FOREMAN, disengaged, desires position; practical and technical training all branches Grey Iron, Semi-Steel, Non-Ferrous work; expert on Cupola; mix metals by analysis; tactful with labour; good organiser.—Box 482, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN MAKER wanted for Jobbing work; must have had previous experience in Constructional work; permanent job for the right man.—Apply Box 486, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

SITUATION connected with Pig or Cast Iron Manufacture desired by Young Man (age 21); A.I. & S.I., A.I.B.F.; five years' experience in Works Lab. of Cast-iron and splendid theoretical training in Iron and Steel Manufacture.—Apply Box 476, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENCIES.

LANCASHIRE TRAVELLER desires to get in touch to represent a firm of Ironfounders specialising in Castings for Engineers up to 6 tons, machined and in the rough.—Address, Box 484, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENTS calling on Foundries wanted in all districts to introduce as additional lines Sand Binders and Cupola Paints.—Apply, with full particulars of district, connection, present lines, etc., to Box 327, c/o JUDD'S, 87, Gresham Street, E.C.2.

TENDERS.

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive Tenders for the SUPPLY OF THE UNDERMENTIONED STORES from the 2nd of July, 1923, to the 31st of December, 1923:—

1.—Laminated Springs.
2.—Helical and Volute Springs.
3.—Steel Tyres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres).
9.— Do. (Miscellaneous).
11.—Chain and Special Iron for Chain Manufacture.
12.—Tubes and Fittings.
13.—Solid Drawn Steel Tubes.
14.—Cast Iron Socket Pipes, Lamp Posts, etc.
15.—Galvanised Sheets.
16.—Tool Steel.

Specifications and Forms of Tender (upon which alone Tenders will be received) may be obtained on application to the Stores Superintendent at Swindon.

Tenders addressed to the undersigned and marked outside "Tender for Iron and Steel" will be received not later than 10.0 a.m. on TUESDAY, the 19th June, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

A. E. BOLTER, SECY.

Paddington Station, London, 5th June, 1923.

FOR SALE BY TENDER.
IRONFOUNDRY FULLY EQUIPPED WITH ALL PLANT, CUPOLAS, Etc.

MESSRS. JOSEPH RHODES & SONS, LIMITED, of Grove Ironworks, Wakefield, offer for sale by Tender

THE following Ironfoundry—

THE SITE is freehold and covers an area of 1,865 square yards or thereabouts.

ALL BUILDINGS thereon are well constructed of brick, and comprise—

IRONFOUNDRY in all 13,136 square feet or thereabouts. CORE STOVES, BLOWER HOUSE,, PATTERN STORE, FETTLING SHOP, Etc.

MOTIVE POWER AND GEARING. WATER, GAS, AND FIRE SERVICES. ELECTRIC LIGHT AND POWER INSTALLATION. TRADE FIXTURES. LOOSE TOOLS AND UTENSILS. TRAMWAYS BOGIES, Etc.

TENDERS.—*Continued.*

THE PLANT consists of 10 tons electric overhead travelling crane, jib cranes, sand mixer, moulding machines, loam mill, cupolas 4 ft. 3 in. dia. and 3 ft. 9 in. dia., and staging, fans, hoist, grinders, etc. Large quantity moulding boxes, ladles, shanks, etc.

POSSESSION CAN BE GIVEN IMMEDIATELY ON COMPLETION.

Application for permission to view should be made to the Firm at the address given below.

J. R. and Sons, Limited, do not bind themselves to accept the highest or any tender.

Tenders endorsed "Foundry" to be delivered to—

JOSEPH RHODES & SONS, LIMITED,
Grove Ironworks, Wakefield.

PATENTS.

INVENTORS Advice, Handbook and Consultations Free. KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London; 36 years' references.

THE OWNER of British Patents Nos. 137,748 and 135,136, both relating to Electric Chain-welding Machines, is desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above inventions, either by Sale of the Patent Rights or by the grant of a Licence or Licences to Manufacture on Royalty.

Inquiries should be addressed to MESSRS. ABEL & IMRAY, Chartered Patent Agents, 30, Southampton Buildings, London, W.C.2.

METHOD OF PRODUCING IRON AND STEEL BARS OF GOOD QUALITY FROM MACHINE-SHOP SCRAPPINGS.

Patent No. 175,686 is for Disposal in Great Britain, either by Sale outright or on Royalty terms.

Full particulars may be obtained from TECHNICAL RECORDS, LIMITED, 59, Lincoln's Inn Fields, London, W.C.2.

MACHINERY.

MACHINERY, PLANT, &c.

One-ton, four-motor, Electric Travelling, UNDERHUNG JIB CRANE; span 20 ft. 7½ in.; built by Messrs. Craven Bros., Manchester, in 1905. Suitable for current at 480 volts continuous; main girders 14 in. x 6 in., R.F.J., with 56 lbs. Bridge Rail riveted on; all motors by Siemens. Crane has been little used and is in good working order. All motions controlled from cage.

Set of Nearly New 3-Throw HYDRAULIC PUMPS; 4 in. rams, 12 in. stroke; driven by 130 h.p. D.C. Motor, 500 volts, 485 revs.

Three Sets of Powerful 3-Throw HYDRAULIC PUMPS, suitable for 2 tons pressure; rams 3 in. diam., 12 in. stroke.

Vertical 3-Throw Geared and Belt-driven HYDRAULIC PUMPS, by Hy. Berry & Co.; 2½ in. rams, 6 in. stroke, 1,500 lbs. working pressure.

Set of 3-Throw Geared and Belt-driven HYDRAULIC PUMPS, 1⅝ in. rams, 3¾ in. stroke, 1,500 lbs. working pressure; by Hy. Berry & Co.

Six first-class LANCASHIRE BOILERS, 30 ft. x 8 ft.; reinsurable working pressure of 140 lbs. per sq. inch.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

FOR SALE.—One Tilting Cupola, 20 in. inside dia., made by Jas. Evans & Company, complete with stand, fan and firebricks; cost £135; had practically no use; will accept low price to clear.—WELLWORTHY, LIMITED, Lymington, Hants.

ONE 10-cwt. Emergency Cupola, £35; Blowing Fan, £8; 4 h.p. Alternating Motor, £20; 1-ton Traveller, 25 ft. span, with double gantries and uprights, £70; Foundry Boxes from 8 in. sq. to 24 in. sq., half-price; 1 3½-cwt. Magnetic Separator, £10; Carr's Furnace, No. 3, £15; ditto, No. 4, double, £20. —THE LONDON ELECTRIC FIRM, CROYDON.

TWO FOUNDRY SAND MIXERS for Sale; latest type; One and Three Tons per hour; clearance prices.—Box 474, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.